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The benefits of giving: Effects of prosocial behavior on recovery from stress

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Abstract

Individuals regularly face stress, and the manner in which they cope with that stress is a crucial component in predicting stress recovery. While many engage in self-rewarding behaviors to feel better, these behaviors can come with a cost. The current study tested the effect of engaging in a different behavior after experiencing stress—prosocial behavior. Given the health benefits associated with giving to others, it is plausible that engaging in prosocial behavior is more successful in reducing the psychological and physiological responses to stress. To test this, participants underwent the Trier Social Stress Test and then either sent a gift card to a person of their choosing, received a gift card for themselves, or selected the more aesthetically pleasing gift card. Measures of self-reported mood, heart rate, blood pressure, salivary alpha-amylase, and cortisol were collected throughout the session. While the manipulation did not elicit differences in psychological or hormonal measures, the giving group showed a significantly greater downregulation of their heart rate, diastolic blood pressure, and mean arterial pressure while recovering from the stressor. Additionally, those in the giving group who evidenced greater prosocial sentiment showed a larger reduction in diastolic blood pressure and mean arterial pressure. A follow-up study suggested that these behaviors may be engaging different reward components, as those who gave a gift card reported greater "liking" while those who received a gift card reported greater "wanting". Overall, the findings show that engaging in prosocial behavior following a stressor can help to downregulate physiological stress responses.

KEYWORDS

affect, cardiovascular, giving, prosocial, stress

1 | INTRODUCTION

Although there has been scientific disagreement in terms of how to accurately define stress, most people know it when they feel it and feel it all too frequently. In fact, recent reports estimate that 60% of Americans experience significant stress on a daily basis (Harter & Witters, 2021). While this statistic suggests that it is common to deal with a high level of stress, the most serious health consequences of stress arise when that stress is poorly managed (American Psychological Association [APA], 2007). Unfortunately, poor stress management behaviors are common; 43% of Americans report overeating or eating unhealthy foods to manage stress while 39% of those who drink and 19% of those who smoke cigarettes are more likely to engage in these behaviors during periods of stress (APA, 2007).

People often turn to these behaviors, amongst many others such as consuming drugs or making expensive purchases ("retail therapy"), because they hold the promise of immediate pleasure (Tice et al., 2001). However, while these behaviors may indeed act as immediate sources of good feelings, they are often at odds with long-term goals such as maintaining a healthy diet, staying sober, or managing one's finances (Tice et al., 2001). Moreover, while many will increase their food intake, particularly with foods high in calories, fat, or sugar (Rutters et al., 2009), when faced with stress, research suggests that this does not enhance recovery of stress as one may assume (Finch et al., 2019). For example, while activities like shopping ("retail therapy") may indeed provide therapeutic power via attentional distraction, self-indulgence, and behavioral activation (Luomala, 2002), individuals have noted that the therapeutic value of the products purchased decreased over time (Kang & Johnson, 2010).

Given both the potential long-term consequences of turning to these behaviors in times of stress along with the mixed findings as to whether they are indeed successful in reducing stress, the need for healthy stress-alleviating behaviors is important. This article will explore the potential of one such behavior, prosocial behavior—or behaviors with the goal of benefitting another person (Nelson et al., 2016)—to reduce the psychological and physiological response to stress.

Prior research has illuminated a range of physical and psychological benefits associated with the prosocial act of giving to others. For instance, the rewarding nature of prosocial behavior has been demonstrated through both neuroimaging and behavioral studies. Neuroimaging studies have shown that behaviors aimed at helping others lead to activation in the ventral striatum—a region of the brain that plays a critical role in basic reward processing (Eisenberger, 2013; Harbaugh et al., 2007; Inagaki & Eisenberger, 2012; Moll et al., 2006; Zahn et al., 2009). Specifically, giving money to others or to charity activates the ventral striatum in the same way, and in some cases even to a larger extent, as does receiving a monetary reward (Harbaugh et al., 2007; Moll et al., 2006). So, while eating high calorie foods, drinking alcohol, and making expensive purchases can be rewarding, so too can engaging in prosocial behavior.

This idea has been mirrored in behavioral research as well, as studies show that spending money on others, as opposed to on oneself, leads to greater self-reported happiness (Dunn et al., 2008). Evidence has also supported the idea that these boosts in happiness from prosocial behavior may be a potential psychological universal, as studies using data from the Gallup World Poll found that humans worldwide derive emotional benefits from prosocial spending in diverse cultural and economic contexts (Aknin et al., 2013). Adding to this, the "warm glow of giving" that one experiences when engaging in prosocial behavior has also been shown to last longer, whereas the happiness one feels from eating the same foods or earning the same income quickly decreases with repeated exposure (O'Brien & Kassirer, 2019). Therefore, not only is engaging in prosocial behavior rewarding, but it may also lead to greater and more consistent reports of happiness.

Aside from boosts in positive mood, prosocial behavior has been tied to a plethora of health benefits as well. Many studies have found the tendency to engage in prosocial behavior to be correlated with improvements in health (Brown & Brown, 2015), a lower risk of mortality (Brown et al., 2003), lower rates of depression (Li & Ferraro, 2005), and daily reductions in heart rate and blood pressure (Piferi & Lawler, 2006). Raposa et al. (2016) conducted a daily diary study in which they found that engaging in higher than usual rates of prosocial behavior was correlated with reductions in the effect of stress on negative affect. Additionally, several studies have found that charitable behavior, volunteering, and giving emotional support to others buffered the negative effects of stress on rates of physical ailments, predicted reduced morbidity and mortality, and was tied to an increase in psychological well-being (Konrath et al., 2012; Poulin et al., 2010, 2013). In addition to these correlational studies, one experimental study has also shown that randomly assigning subjects to engage in prosocial behavior prior to a stressor can causally reduce stress responding. Specifically, giving social support to a loved one prior to engaging in a stressor reduced sympathetic nervous system-related responses (systolic blood pressure, salivary alpha-amylase [sAA]) during the stressor itself (Inagaki & Eisenberger, 2016).

One potential explanation for the health benefits associated with giving comes from Porges' Polyvagal Theory, which proposes that activity of the vagus nerve, associated with parasympathetic responses, helps facilitate mammalian affiliative social behaviors (Porges, 2007). Thus, increases in vagal activity slow the heart and may induce a relaxed state that would subsequently promote social engagement and bonding with others (Stellar et al., 2015). One study testing this idea showed that vagal activity (estimated by high frequency heart rate variability) predicted prosocial cooperation (Beffara et al., 2016), suggesting that increased parasympathetic activation when giving (and thus reduced sympathetic nervous system [SNS] activity) may have benefits for health outcomes.

Based on these findings, it seemed plausible that prosocial behavior could be used to reduce the negative consequences of stress, perhaps in a manner more beneficial than self-rewarding behavior. To examine this, participants engaged in a stressful task and were then randomly assigned to either engage in prosocial behavior (giving a gift card to someone they know), self-rewarding behavior (receiving a gift card for themselves), or a neutral control task. Given the mental and physical health benefits of prosocial behavior, we examined psychological and physiological measures of stress throughout the study session. To assess psychological responses to stress, we measured self-reported positive and negative affect. To assess physiological measures of stress, we measured cardiovascular responses that have been shown to increase as a function of stress and increased SNS activity (heart rate, blood pressure; Allen et al., 2014; Feldman et al., 1999) and have been shown to be predictive of later cardiovascular problems (Chida & Steptoe, 2010). We also assessed salivary measures that have been shown to increase as a function of stress (Dickerson & Kemeny, 2004; Nater & Rohleder, 2009), including sAA (an enzyme that indexes SNS activity) and salivary cortisol (indexing HPA axis activity). We hypothesized that those who engaged in prosocial behavior after the stressor would show a greater reduction in their psychological and physiological stress responding compared to those who engaged in self-rewarding behavior or completed a control condition.

Additionally, we were interested in more closely dissociating the psychological experience of prosocial versus self-rewarding behavior. While past research has indicated that both activities seem to elicit positive mood, we aimed to distinguish what discrete emotions each behavior may produce. By doing so, we may gain insight into the underlying psychological mechanisms by which prosocial behavior may be tied to positive health outcomes. To explore this, we conducted a follow-up study focused on dissociating giving versus receiving on the basis of two psychological components of reward —"liking" versus "wanting". "Liking" has been defined as the experience of hedonic pleasure associated with consuming a reward (Berridge et al., 2009; Winkielman et al., 2005), whereas "wanting" promotes approach toward rewards (Berridge et al., 2009). While both giving and receiving something for oneself can be rewarding, we aimed to investigate whether these rewarding experiences were psychologically dissociable on the basis of these varying components of reward. Thus, we conducted a follow-up study (Study 2) to more closely disentangle the positive emotions that arise in response to prosocial versus self-rewarding behaviors.

2 | STUDY 1

2.1 | Method

2.1.1 | Study design

Participants in the study completed an acute laboratory-based stressor, the Trier Social Stress Test (TSST; Kirschbaum et al., 1993), while in the lab. This is a classic stress reactivity paradigm used to assess stress reactivity and recovery linked to stress-related disease (Allen et al., 2017). Following the stress task, participants were assigned to 1 of 3 conditions—a "giving" condition (prosocial behavior), a "receiving" condition (self-rewarding behavior), or a control condition. By eliciting social-evaluative threat, the TSST is known to reliably increase cardiovascular and cortisol responses, and thus the appropriate task for measuring both changes in mood and physiological response (heart rate, blood pressure, mean arterial pressure, cortisol, and sAA) in response to the manipulation task.

2.1.2 | Participants

We recruited 91 healthy UCLA undergraduate students through UCLA's Psychology subject pool (55 females, 35 males, 1 other) with a mean age of 20.84, $SD = 2.98$. In order to be eligible for the study, participants needed to confirm prior to the study that they were 18 years old or older and fluent in English. Additionally, they were required to confirm that they did not have any major physical or mental health disorders, uncontrolled hypertension, active coronary artery disease or significant arrhythmia, current insulin-dependent diabetes, have a history of stroke, a fear of public speaking, a presence of current major injuries or illness, or are taking any medications that affect hormones. The sample of 91 participants had an ethnic breakdown of 46.2% Asian, 27.5% Caucasian, 12.1% reporting other, 11% Hispanic, 2.2% African American, and 1.1% Native American.

Participants were dropped from our physiological analyses if they were missing data at key time points (such as during the stressor) due to equipment malfunctions. Therefore, our cardiovascular analyses included 79 of the 91 total participants. Analyses of sAA included 88 of the 91 participants, while cortisol analyses included all 91 participants. Procedures were approved by UCLA's Institutional Review Board, and all participants received 2 hr-worth of research credit for their participation.

2.1.3 | Procedure details

Participants were scheduled for a 2-hr session in the lab. The sessions ran from 2–4 p.m. to 4–6 p.m. to control for natural diurnal variations in cortisol and alpha-amylase activity (Dickerson & Kemeny, 2004). Participants were asked to refrain from eating food or drinking any beverages aside from water 2 hr before the session start time. This was confirmed once they arrived for the study. An outline of the lab procedure is provided in Figure 1.

Baseline

Once participants entered the lab and signed the consent form, they were familiarized with the Dinamap PRO Monitor, an automated device used to collect heart rate and blood pressure throughout the study. Participants were attached to the Dinamap before they began their baseline surveys, which allowed the monitor to begin collecting measures automatically every 3 min throughout the rest of the study. The baseline survey included demographic questions and measures of physical and mental health. Baseline mood was collected as well. Upon completion of the baseline questionnaire, participants gave their first saliva sample, measuring baseline cortisol and sAA levels.

Trier Social Stress Test (laboratory stressor)

The experimenter then gave participants detailed instructions about the upcoming TSST. Participants were told they would first be giving a speech in front of a panel of evaluative judges, in which they were to explain why they would be the best candidate for an administrative assistant position. Participants were then given 5 min to sit quietly and prepare for this speech, which they were told would be the first task they would complete in front of the panel of judges. Heart rate and blood pressure measures were collected every 3 min throughout the study and grouped together as the "prep" period during this time.

After the 5 min of preparation period, two trained research assistants entered the room, which signaled the start of the TSST. The research assistants were trained to keep a neutral demeanor and wore lab coats to establish prestige. The participant was told to speak for 5 min about why they would make a good candidate for an administrative assistant position. Research assistants (confederates) were told to be stern, avoid nodding, smiling, or giving any positive feedback and pretended to take notes regarding the participant's performance. The confederates timed each portion of the TSST, and the participant was told to speak for the entire time (indicated by a stopwatch that they could see while delivering their speech).

Following the speech task, the participant was told to complete an additional 5-min mental arithmetic task, in which they were instructed by the confederates to count aloud backwards from 2,023 by 17s. Participants were told they must count as quickly and accurately as possible, and should they miscalculate, they must start from the beginning at 2,023. Immediately after the TSST, participants gave their second saliva sample, indexing both sAA and cortisol levels during stress. Participants then gave their second mood assessment, related to how they felt during the TSST. HR/BP measurements were again collected every 3 min throughout this period and grouped together as "post-TSST".

Manipulation

Next, participants were randomly assigned to 1 of 3 conditions—either a giving condition (prosocial behavior), receiving condition (self-rewarding behavior), or control condition (see Supplementary Materials for an overview of the manipulation task).

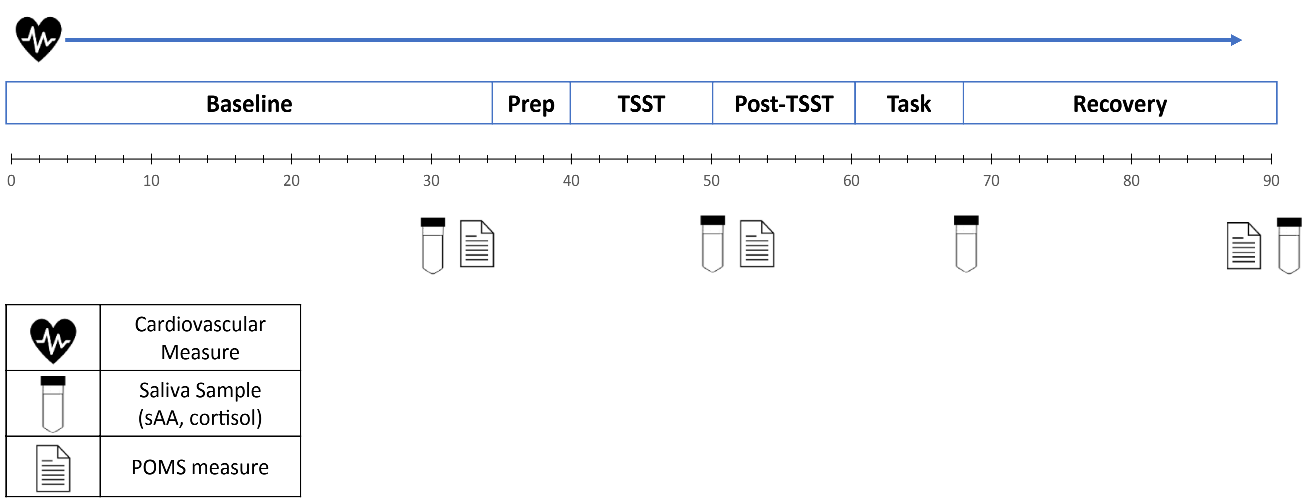

FIGURE 1 An overview of study procedures with timing information. Starting at baseline, participants were attached to the Dinamap PRO Monitor, which collected measures of heart rate and blood pressure every 3 min throughout the entire session. Following the Trier Social Stress Test and post-stress period, participants completed the manipulation task, in which they either selected a gift card for someone they know (giving condition), selected a gift card for themselves (receiving condition), or selected gift cards based on what was more aesthetically pleasing (control condition). Additionally, measures of cortisol, salivary alpha-amylase, and affective responses were collected at specific timepoints throughout the session

In the "giving" condition, participants were given the following instructions:

> Think of someone you know who may be in need, has been having a hard time recently, or who you simply want to do something nice for. In this next task, you will be making decisions between different gift cards based on what **your selected person** may want or need. This person will receive one of the gift cards you selected for them via email. Please write their email in the text box below.

They then selected between various pairings of 2 different gift cards, a total of 10 times (choosing between a total of 5 different gift cards, paired in different ways). At the end of the task, participants were shown the following message: *You may write a message for the person you selected below. This will be sent in the email along with the gift card. Your name will not be disclosed in the email, but you may write it in the message if you wish*. They were then told which gift card they won for their selected person, with the following message: *Congratulations! You have won the person you selected a/an _______ **Gift Card**! This will be emailed to them within the next week*. The messages written in the giving condition were later coded based on their overall level of prosocial sentiment (see Measures section).

In the "receiving" condition, participants chose between the exact same gift cards (completed the same task). However, the instructions for the task were different. Instead of selecting a gift card for someone else, the participant was told to select a gift card for themselves. They were given the following instructions:

> In the following task you will be asked to choose between different gift cards based on your **personal preference**. At the end of the task, we will randomly select one of the gift cards you chose. This gift card will be emailed to you at the conclusion of the study. Please provide your email below.

They then chose between the same gift cards as the giving condition (selecting 1 of 2 different gift cards, 10 times). At the end of the task, they were shown the following response: *Congratulations! You have received a/an ________ Gift Card. Expect to be emailed this gift card within the next few days*. The participant either received a $10 Amazon or Target gift card via email upon conclusion of their session.

Lastly, in the control condition, participants again completed the same gift card task, but were instructed to do the following:

> In the following task you will be asked to select the gift card you find more **aesthetically pleasing**--as in, the gift card you believe has been designed better.

There was no giving or receiving of gift cards in this condition.

Recovery

Following the manipulation task, participants gave their third saliva sample, indexing cortisol at post-stress and sAA levels in response to the manipulation. For the remainder of the study, participants completed a final survey, including their third and final mood assessment. They were given 15 min to complete the survey and were told to sit and relax should they finish early. Following this period, the fourth and final saliva sample was collected (indexing cortisol and sAA at recovery), and participants were debriefed. While the fourth saliva sample was intended to assess cortisol at recovery, not enough time elapsed for it to be used as a reliable measure of recovery (which is further discussed in the results). All HR/BP recordings following the manipulation task were grouped together as "recovery".

2.2 | Measures

2.2.1 | Demographic measures

Participants self-reported on demographic relevant health variables such as age, subjective health ("how would you describe your health?"), coffee and alcohol intake in the past 2 hr and in the last 7 days, amount of exercise on the day of the session, cigarette use, sleeping pattern, employment status, and use of oral contraceptives. Baseline depression was measured using the Beck Depression Inventory, with the removal of 2 questions regarding suicidality (BDI; Beck et al., 1961). These measures were used to assess any baseline differences between the groups.

2.2.2 | Affective measures

In order to capture feelings of positive and negative mood in response to the stressor and subsequent manipulation, we administered an adapted version of the Profile of Mood States short form (POMS-SF) three different times throughout the session: (1) at baseline, (2) immediately following the TSST, and (3) at recovery. The POMS is a psychological rating scale that is used to assess transient, distinct mood states (McNair et al., 1981). Because the length of the original POMS can be limiting for repeated use within one session, an adapted version of the short form (POMS-SF) was used, given that the internal consistency estimates are comparable to the original (Curran et al., 1995). The revised final version of the POMS-SF included the following subscales: Anxiety/Tension ($\alpha = 0.828$, 6 items: e.g., uneasy, nervous, anxious), Depression ($\alpha = 0.928$, 8 items: e.g., miserable, discouraged, hopeless), Anger ($\alpha = 0.932$, 8 items: e.g., resentful, annoyed, spiteful), and Positive Mood ($\alpha = 0.860$, 8 items: e.g., good-natured, friendly, in a positive mood). Participants were asked to indicate the extent to which they felt each of the 30 items presented. To reduce the number of statistical tests and because measures of anxiety/tension, depressed affect, and anger were highly correlated at all phases of the study (baseline ($\alpha = 0.92$), post-TSST ($\alpha = 0.87$), and recovery ($\alpha = 0.81$)), we created a composite measure of the negative mood items. The positive mood items remained as a separate measure.

2.2.3 | Physiological measures

Cardiovascular measures

We measured cardiovascular responses that have been shown to increase as a function of stress (Allen et al., 2014; Feldman et al., 1999), including heart rate (HR; beats per minute), systolic blood pressure (SBP; maximum pressure as the heart contracts), diastolic blood pressure (DBP; minimum pressure as the heart fills with blood), and mean arterial pressure (MAP, accounts for flow, resistance, and pressure within arteries). Increases in these measures are observed immediately in response to stress, and continue throughout stress exposure (Allen et al., 2014). Cardiovascular measures were assessed with a Dinamap PRO Monitor, an automated monitor that is able to measure heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) throughout the entire duration of the study. The cuff connected to the Dinamap was placed on the participant's nondominant arm at the start of the study, and readings were automatically collected every 3 min throughout the duration of the study. Mean arterial pressure accounts for both systolic and diastolic pressures and was estimated via the formula:$\text{MAP} = \frac{2(\text{DBP})+\text{SBP}}{3}$ (Allen et al., 2014; Rodríguez-Medina et al., 2019). Values within each measurement phase were averaged in order to calculate the overall cardiovascular response for HR, SBP, DBP, and MAP at each time period. Aggregating measurements within each phase enhances reliability and reduces measurement error (Kamarck et al., 2000).

Saliva samples

Saliva samples assessing cortisol and alpha-amylase were collected four separate times throughout the experimental protocol. Samples were collected using salivettes (Salivettes, Salimetrics, Carlsbad, CA) that participants were instructed to hold in their mouth for 3 min. Saliva was collected once at baseline (20 min after entering the lab), twice immediately after the stress task and after the manipulation task, and once during recovery (35 min after the end of the stress task). Samples were immediately stored in a −20°C freezer until completion of the data collection phase. All samples were then sent to the Technical University of Dresden in Dresden, Germany, to the biological psychology laboratory directed by Dr. Clemens Kirschbaum. Samples were then analyzed with a time-resolved fluorescence immunoassay (Dressendörfer et al., 1992). Cortisol and sAA values were not normally distributed, therefore, log-transformed measures of cortisol and sAA were used in all analyses.

Cortisol. Cortisol is a commonly studied hormone associated with stress and was measured due to its association with the hypothalamic-pituitary-adrenocortical axis response (HPA axis). As such, cortisol can serve as a measure of stress reactivity and recovery. Because cortisol requires around 15–20 min to rise or fall in response to an event, the first cortisol sample was collected at least 20 min after the participant came in for the study, serving as a baseline measure. The second cortisol sample was collected immediately following the completion of the TSST, approximately 20 min after the start of the TSST prep period, thus indexing cortisol levels to stress. The third sample was taken after the participant completed the manipulation task, approximately 35 min after the start of the TSST prep period (post-stress). The fourth and final saliva sample was collected 20 min after the manipulation task (which was approximately 55 min after the start of the TSST prep period), although this timing was not suitable to collect an accurate sample of cortisol levels at recovery.

Salivary alpha amylase. sAA is an enzyme which serves as an index of SNS activity and has been shown to rise quickly in response to stress (Nater & Rohleder, 2009; Rohleder et al., 2004). However, it is important to mention that the literature on sAA is mixed, and while the SNS is one signaling pathway sAA can tap into, there may be others as well.

In the current work, sAA and cortisol measures were collected in the same 4 saliva samples. However, the third saliva sample (collected immediately after completion of the manipulation) indexed sAA in response to the manipulation itself, while this sample indexed cortisol levels post-stress. All other samples of sAA and cortisol corresponded to the events of the experiment in the same way (baseline, stress, recovery).

2.2.4 | Writing-related measures: Prosocial sentiment

While not required to do so, 93% of participants within the giving group chose to write more than just their name when sending a message to their chosen gift-card recipient. These messages were later rated by two independent judges on a scale of 1 to 5 based on how "thoughtful," "caring," "warm," and "affectionate" the messages were. Ratings within each measure were averaged across the independent raters (inter rater reliability $\alpha = 0.898$), and then averaged across the four measures ($\alpha = 0.891$) to form a composite score of overall prosocial sentiment. This composite score was used to measure whether those who expressed a higher level of prosocial sentiment in the giving group experienced greater effects of the manipulation.

2.3 | Statistical analysis plan

Baseline measures, including all demographic information and self-reported health measures (described above), were compared across the three conditions (giving, receiving, and control conditions) using one-way ANOVAs in SPSS. There was a significant between-group difference in baseline depression (as assessed by the BDI), $F(2,90) = 5.520$, $p = .006$, such that the receiving condition ($M = 10.48$, $SD = 5.65$) had significantly higher levels of depression as compared to the giving ($M = 6.07$, $SD = 4.02$) and control ($M = 7.41$, $SD = 5.81$) conditions. Because of this, baseline depression was included as a covariate in all subsequent between-group analyses to ensure that any observed differences by condition were not due to differences in depression levels. Aside from depression score, no other baseline demographic or self-reported health variables were significantly different at baseline.

Additionally, although prior work has observed sex differences in response to the TSST (Kirschbaum et al., 1992; Kudielka & Kirschbaum, 2005; Smith et al., 2009; Stoney et al., 1987), we observed no significant interactions with sex and thus did not include sex as a covariate.

2.3.1 | Effects of the TSST

First, in order to examine whether the TSST was effective in increasing self-reported and physiological stress responses, we focused on measures taken at baseline through the TSST task. For self-reported mood, a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: baseline vs. post-TSST) repeated measures ANCOVA was run for each category of affective response (negative mood composite, positive mood), controlling for depression. For each cardiovascular outcome (HR, DBP, SBP, MAP), we conducted a 3 (Condition: giving vs. receiving vs. control) × 3 (Time: baseline vs. prep period vs. TSST) repeated measures ANCOVA, controlling for depression. Finally, for sAA and cortisol measures, we conducted a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: baseline vs. post-TSST) repeated measures ANCOVA, controlling for depression.

2.3.2 | Effects of the manipulation

Next, to examine the effect of the prosocial manipulation on stress recovery, we focused on measures from post-TSST to the end of the recovery period. For self-reported mood, we conducted a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: post-stress vs. recovery) repeated measures ANCOVA, controlling for baseline mood as well as baseline depression, for the negative mood composite as well as the positive mood outcome. For each of the cardiovascular measures, we conducted a 3 (Condition: giving vs. receiving vs. control) × 3 (Time: post-stress vs. manipulation vs. recovery) repeated measures ANCOVA, controlling for cardiovascular responses during both baseline and the TSST (to control for individual differences in baseline cardiovascular measures along with the peak of the stress response) as well as baseline depression. For the measures collected via saliva samples, for cortisol we conducted a 3 (Condition: giving vs. receiving vs. control) × 3 (Time: TSST vs. post-stress vs. recovery) repeated measures ANCOVA, controlling for baseline cortisol levels along with baseline depression. For sAA, we conducted a similar 3 (Condition: giving vs. receiving vs. control) × 3 (Time: TSST vs. manipulation vs. recovery) repeated measures ANCOVA, again controlling for baseline sAA along with baseline depression. If any omnibus tests were significant, post-hoc analyses were performed.

In addition, for any significant differences observed as a function of the manipulation, we further examined whether effects in the prosocial condition were stronger for those rated as scoring higher on prosocial sentiment. To keep prosocial sentiment as a continuous variable, the repeated measures ANCOVA analysis could no longer be used. Thus, instead we ran two-level multi-level models for each outcome, using time (post-stress, post-manipulation, recovery) as a within-subjects factor. Prosocial sentiment and the covariates (baseline and TSST measures of HR/DBP/MAP) were treated as level 2 between-subjects factors. The model examined the interaction of prosocial sentiment score by time (linear). Analyses were run on STATA 15.1 (College Station, TX).

2.4 | Results

2.4.1 | Overview

The analyses were conducted in two steps. We first examined whether the TSST increased self-reported and physiological stress responses. Specifically, to the extent that the TSST worked, it should result in increases in negative mood, decreases in positive mood, increases in cardiovascular responses, and increases in both cortisol and sAA. Moreover, because the manipulation was introduced after the completion of the TSST, we also tested to make sure that there were no effects of the manipulation (i.e., no time by condition interactions) on these outcomes.

Second, to the extent that the TSST increased stress responses, we could next investigate whether the manipulation altered recovery from the TSST. Specifically, we examined whether the prosocial manipulation led to larger decreases in negative mood, larger increases in positive mood, larger decreases in cardiovascular responses, and larger decreases in both cortisol and sAA during the recovery period after the TSST.

2.4.2 | Did the TSST increase self-reported and physiological stress responses?

Self-reported mood

First focusing on self-reported negative mood, we conducted a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: baseline vs. post-stress) repeated measures ANCOVA (controlling for baseline depression). As expected, results demonstrated a significant effect of time ($F[1,86] = 31.32$, $p < .001$), such that levels of negative affect increased as a function of the TSST. Moreover, as expected, there was no time by condition interaction (as the manipulation had not occurred yet; $p > .50$).

Next, with regard to self-reported positive mood, a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: baseline vs. post-stress) repeated measures ANCOVA (controlling for baseline depression) revealed a significant effect of time ($F[1,86] = 63.05$, $p < .001$), such that levels of positive mood decreased as a function of the TSST. Moreover, as expected, there was no time by condition interaction (as the manipulation had not occurred yet; $p > .50$).

Cardiovascular responses

To examine whether the TSST increased cardiovascular responses, we conducted a 3 (Condition: giving vs. receiving vs. control) × 3 (Time: baseline vs. prep period vs. TSST) repeated measures ANCOVA, controlling for baseline depression for each cardiovascular measure: HR, SBP, DBP, and MAP. As expected, results demonstrated a significant effect of time for HR ($F[2,158] = 48.158$, $p < .001$), SBP ($F[2,160] = 103.827$, $p < .001$), DBP ($F[2,160]] = 72.039$, $p < .001$), and MAP ($F[2,160] = 115.842$, $p < .001$), such that cardiovascular responses increased from baseline to the prep period ($ps < .001$) and from the prep period to the TSST ($ps < .001$). Moreover, as expected, there was no time by condition interaction ($ps > .705$).

Cortisol

To examine whether the TSST increased cortisol, we conducted a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: baseline vs. post-TSST) repeated measures ANCOVA, controlling for baseline depression. Consistent with prior TSST studies, results demonstrated a significant increase in cortisol across all conditions ($F[1,87] = 12.34$, $p < .002$) and no time by condition interaction ($p > .89$).

sAA

To examine whether the TSST increased sAA, we conducted a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: baseline vs. post-TSST) repeated measures ANCOVA, controlling for baseline depression. As expected, results demonstrated a significant increase in sAA across all conditions ($F[1,84] = 8.38$, $p < .006$) and no time by condition interaction ($p > .92$).

2.4.3 | Did giving (versus receiving and control) lead to greater downregulation of self-reported and physiological stress responses during recovery?

Since the TSST was successful in increasing self-reported and physiological stress responses, we could now examine whether a prosocial manipulation, delivered after the TSST, led to a greater decrease in these stress outcomes.

Self-reported mood

To examine the effect of the manipulation on changes in self-reported mood, we conducted a 3 (Condition: giving vs. receiving vs. control) × 2 (Time: post-stress vs. recovery) repeated measures ANCOVA, controlling for baseline mood as well as baseline depression (as assessed by the BDI) for both negative mood and for positive mood. First, with regard to the negative mood composite, although there was a significant main effect of time, such that all groups showed an increase in negative mood during the recovery period ($F[1,85] = 5.58$, $p < .03$), there was no time by condition interaction ($F[2,85] = 0.49$, $p = .61$) and thus no effect of the manipulation. For positive mood, there was no effect of time ($F[1,85] = 0.76$, $p = .39$), indicating that the groups showed no change in positive mood across the recovery period. There was also no time by condition interaction ($F[2,85] = 1.25$, $p = .29$), indicating no effect of the manipulation. Thus, across both positive and negative mood, there was no effect of the prosocial manipulation on self-reported mood changes during the recovery period.

Cardiovascular responses

To examine the effect of the prosocial manipulation on changes in each of the cardiovascular responses during the recovery period, we conducted a 3 (Condition: giving vs. receiving vs. control) × 3 (Time: post-stress vs. manipulation vs. recovery) repeated measures ANCOVA, controlling for cardiovascular responses during baseline and the TSST (to control for individual differences in both baseline levels along with the peak of the stress response) as well as baseline depression.

Heart rate

As hypothesized, there was a significant time by condition interaction ($F[4,146] = 3.37$, $p = .011$; see Figure 2a), such that the giving group showed a larger decrease in HR than either the receiving group ($F[2,98] = 5.18$, $p = .007$), or the control group ($F[2,90] = 4.34$, $p = .016$). Moreover, there was no difference in HR between the receiving and control groups ($F[2,98] = 1.19$, $p = .308$). Thus, participants in the giving condition had significantly greater reductions in HR across the recovery period compared to the receiving and control groups.

Systolic blood pressure

There was no significant time by condition interaction for SBP ($F[4,146] = 1.15$, $p = .336$; see Figure 2b). Thus, the groups did not differ in their reductions of SBP throughout the recovery period.

Diastolic blood pressure

Similar to HR, there was a significant time by condition interaction for DBP ($F[4,146] = 3.48$, $p = .009$; see Figure 2c), such that the giving group showed a greater decrease in DBP than the receiving group ($F[2,98] = 6.57$, $p = .002$) and a marginally significant decrease compared to the control group ($F[2,90] = 2.44$, $p = .09$). The receiving and control groups did not differ ($F[2,98] = 1.64$), $p = .20$).

Mean arterial pressure

Results indicated a significant time by condition interaction, ($F[3.66,133.75] = 2.75$, $p = .03$; see Figure 2d), such that the giving group evidenced greater decreases in MAP compared to the receiving group ($F[2,98] = 5.62$, $p = .005$) and the control group ($F[2,90] = 3.44$, $p = .037$). The receiving and control groups did not significantly differ from one another ($F[2,98] = 0.183$, $p = .833$).

To further explore these significant effects of the giving condition on HR, DBP, and MAP, we also examined whether those most affected by the giving manipulation showed the largest reduction in cardiovascular responding. Specifically, we explored whether subjects in the giving condition who evidenced more prosocial sentiment, as rated from their written messages, showed larger reductions in HR, DBP, and MAP across the recovery period. Results indicated a significant prosocial sentiment by time interaction for DBP ($b = -1.14$, $se = 0.37$, $p < .01$) and MAP ($b = -0.95$, $se = 0.36$, $p = .01$), such that those who expressed higher prosocial sentiment in their messages also showed larger reductions in DBP and MAP (but not HR; $b = -0.66$, $se = 0.47$, $p = .16$) across the recovery period (Figure 3a,b). These data suggest that not only does engaging in prosocial behavior lead to reductions in the cardiovascular response after stress, but the extent of prosocial sentiment displayed may also lead to greater downregulation effects.

Cortisol

To examine the effect of the prosocial manipulation on changes in cortisol during the recovery period, we focused on the final 3 cortisol assessments and conducted a 3 (Condition: giving vs. receiving vs. control) × 3 (last 3 time points: stress vs. post-stress vs. recovery) repeated measures ANCOVA, controlling for baseline cortisol and baseline depression. Results did not indicate a significant time by condition interaction ($F[3.21,136.32] = 1.17$, $p = .326$, Greenhouse-Geisser corrected), signifying that the conditions did not differ in their ability to reduce cortisol across the recovery period. While the interaction was not significant, it is worth noting that changes in cortisol across the session were in the expected direction, as participants in the prosocial condition showed the lowest levels of cortisol across the post-stress and recovery periods (see Figure 4a). Additionally, it is possible that given the timing of saliva samples, we were unable to index cortisol at recovery with the final saliva sample. Thus, we may be lacking a measure of cortisol at recovery.

Salivary alpha-amylase

To examine the effect of the manipulation on changes in sAA levels during the recovery period, we focused on the final 3 sAA assessments and conducted a 3 (Condition: giving vs. receiving vs. control) × 3 (last 3 time points: stress vs. manipulation vs. recovery) repeated measures ANCOVA, controlling for baseline sAA and baseline depression. Like cortisol, there was no time by condition interaction, $F(4,162) = 0.19$, $p = .95$. The manipulation did

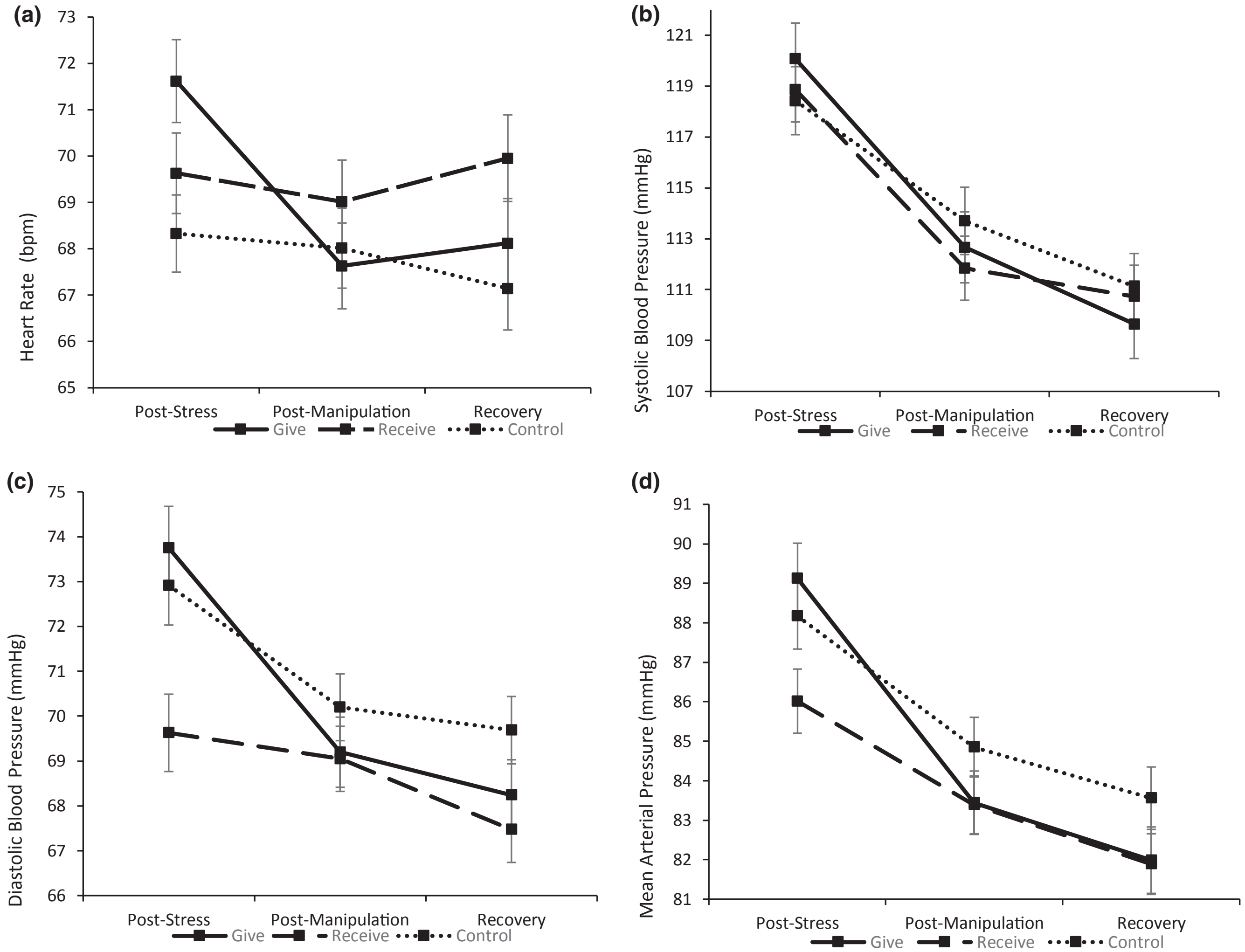

FIGURE 2 HR, SBP, DBP, and MAP during the post-stress, manipulation, and recovery periods, controlling for baseline responding, Trier Social Stress Test responding, and baseline depression. (a) HR: Participants in the giving condition showed a larger decrease in heart rate after stress compared to the receiving and control conditions. (b) SBP: There was no effect of the manipulation found. (c) DBP: Participants in the giving condition showed a larger decrease in DBP after stress compared to the receiving and control conditions. (d) MAP: Participants in the giving condition showed a larger decrease in MAP after stress compared to the receiving and control conditions. Error bars reflect standard errors

not lead to between-group differences in reduction of sAA across the recovery period (see Figure 4b).

3 | SUMMARY OF RESULTS

In sum, statistical analyses revealed that engaging in prosocial behavior was effective in downregulating HR, DBP, and MAP following stress, compared to engaging in self-rewarding behavior or completing a control condition. However, there were no differences in sAA or cortisol responses, and prosocial behavior did not seem to have an effect on self-reported changes in mood.

Given previous work showing that giving to others can lead to increases in positive affect, and these increases can be even greater than when receiving something for oneself, it is possible that while prosocial behavior does not uniquely lead to reductions in negative affect, it may differ from self-rewarding behavior by virtue of the specific positive emotions each elicits. Given that we focused on a broad measure of positive affect in Study 1 (positive mood), we aimed to investigate this further by measuring more discrete types of positive affect in Study 2. While the extent to which an individual in the giving condition expressed prosocial sentiment was shown to be associated with even greater reductions in DBP and MAP, this measure of prosocial sentiment was based on what participants wrote rather than their self-reported feelings. Administering a more specific measure aimed at understanding discrete positive emotions can provide a clearer picture as to what may be contributing to the cardiovascular effects. Thus, Study 2 investigated the potential

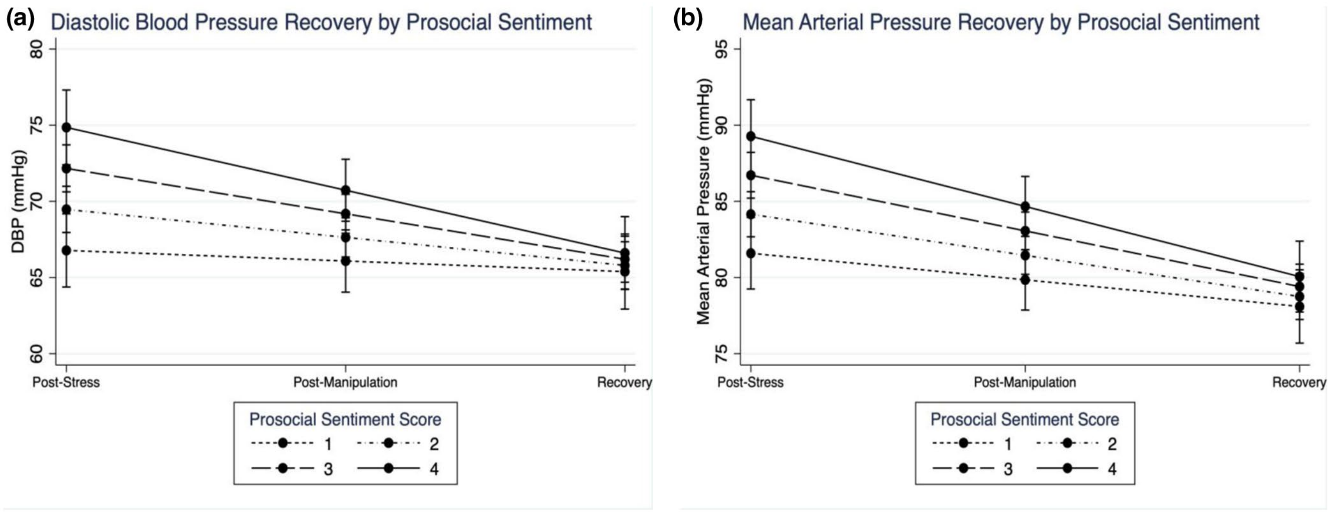

FIGURE 3 DBP and MAP recovery (giving group only) by prosocial sentiment score during post-stress, manipulation, and recovery periods (controlling for baseline and Trier Social Stress Test responding). Error bars represent standard errors. (a) DBP: Those who evidenced a higher prosocial sentiment showed a significantly larger decrease in DBP during stress recovery. (b) MAP: Those who evidenced a higher prosocial sentiment showed a significantly larger decrease in MAP during stress recovery

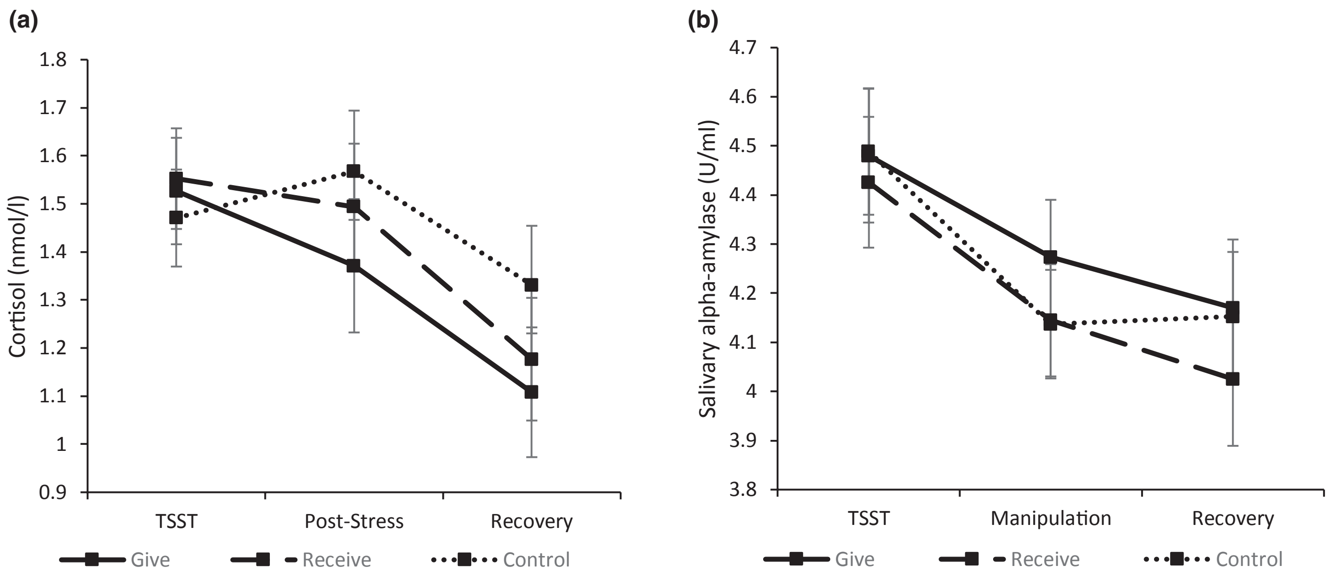

FIGURE 4 (a) Cortisol responding during the Trier Social Stress Test (TSST), post-stress, and recovery periods, controlling for baseline cortisol and baseline depression. There was no effect of the manipulation found. (b) sAA responding during the TSST, manipulation, and recovery periods. There was no effect of the manipulation found. Error bars represent standard errors

distinct positive emotions that prosocial behavior versus self-rewarding behavior may elicit.

4 | STUDY 2

While decades of previous work have concluded that both giving to others and receiving something for yourself is rewarding, the specific positive emotions that each may elicit remains less clear. Given the fact that Study 1 showed that prosocial behavior, but not self-reward, reduced cardiovascular responding following a stress task, it is important to investigate the different types of positive emotions that might distinguish these two rewarding states. Research has established two components of rewarding experiences—"liking" versus "wanting"—that are dissociable both psychologically and neurobiologically (Berridge et al., 2009). "Liking" is the reaction to the pleasure of a reward, and it is what most people mean when they say "rewarding" (Berridge, 2009), while "wanting" is defined by the motivation to seek out and consume rewards (Robinson et al., 2015). "Wanting" is a psychological process of incentive salience, which attributes rewards to their predictive cues, such as a craving being triggered by the sight, smell, or taste of foods (Berridge, 2009). We hypothesized that measuring these separate components of reward would bring to light potential psychological differences between the rewarding nature of giving versus receiving. Thus, we shifted to an instrument that is sensitive to discrete positive emotions rather than the more typical broad dimensions of affect, through administration of the Discrete Emotions Questionnaire (DEQ) (Harmon-Jones et al., 2016). The DEQ allows for the differentiation of discrete dimensions of positive affect, specifically happiness (more akin to "liking") versus desire (more akin to "wanting"), rather than looking at positive affect more broadly. Thus, we hypothesized that the differences between giving and receiving a gift card may arise from differences in the experience of these two components of reward, with giving leading to increased happiness and receiving leading to increased desire.

4.1 | Method

We recruited 102 UCLA undergraduates (75 females) through UCLA's Sona System, and this study was approved by UCLA's Institutional Review Board. The sample had an ethnic breakdown of 44.1% Asian, 31.4% European American, 10.8% Hispanic/Latinx, 7.8% Multi-ethnicity, 3.9% listed as Other, and 2% Black or African American, with an average age of 20.33, $SD = 2.18$. Participants completed the same gift card task online (as described in the main study, with the same set of instructions), in which they were randomly placed in either the giving or receiving condition (excluding the previous control condition). Following the gift card task, participants completed a shortened 11-item version of the Discrete Emotions Questionnaire (Harmon-Jones et al., 2016). Participants were told to rate the extent to which they experienced each emotion while completing the gift card task, on a scale of 1 (not at all) to 7 (an extreme amount). Participants were only asked to rate items from the happiness ($\alpha = 0.939$, 4 items: happy, enjoyment, liking, satisfaction), desire ($\alpha = 0.935$, 4 items: wanting, desire, craving, longing), and relaxation ($\alpha = 0.895$, 3 items: chilled out, calm, easygoing) subscales. Relaxation was included as an exploratory item. Ratings within each subscale were added to get a sum for happiness, desire, and relaxation.

4.2 | Results

Independent samples *t*-test analyses revealed the giving group reported significantly stronger levels of happiness ($M = 20.86$, $SD = 4.957$) as compared to the receiving group ($M = 17.58$, $SD = 5.937$), $t(100) = 3.038$, $p < .01$. Additionally, the receiving group reported significantly stronger levels of desire ($M = 13.91$, $SD = 6.498$) compared to the giving group ($M = 10.93$, $SD = 6.520$), $t(100) = -2.279$, $p = .02$. The groups did not differ in their relaxation levels, $t(100) = 1.573$, $p = .12$. Hence, even though prior work has shown that engaging in prosocial behavior and self-rewarding behavior activate similar reward-related neural regions, this work demonstrates that engaging in prosocial versus self-rewarding behavior elicits different forms of positive affect.

4.3 | Discussion

Given that stress is pervasive and affects virtually all living beings (Selye, 1976), there are a plethora of ways in which individuals attempt to regulate and reduce that stress. While it is common to eat high-calorie foods or make expensive purchases in times of stress, this study explored what happens when one chooses to engage in a potentially less impulsive means of dealing with stress—prosocial behavior. Previous work has established that engaging in prosocial behavior is associated with a host of positive outcomes, noting activation in reward regions of the brain (ventral striatum) when one gives to another, along with greater self-reported happiness after engaging in prosocial behavior (Dunn et al., 2008; Harbaugh et al., 2007; Moll et al., 2006). Coupled with studies uncovering the physical health benefits associated with prosocial behavior, prior work has been instrumental in highlighting prosocial behavior as a potential method of stress reduction. However, given that most past work is correlational in nature, the potential direct physiological and psychological outcomes of prosocial behavior have yet to be uncovered (Poulin & Holman, 2013; Raposa et al., 2016). The current study tested whether engaging in prosocial behavior after stress improves stress recovery, and thus contributes to past research by experimentally measuring the causal effects of prosocial behavior on psychological and physiological stress responses.

Findings revealed that those who had the opportunity to give to another exhibited reduced HR, DBP, and MAP when recovering from a stressful experience. This result is consistent with previous work and establishes that engaging in prosocial behavior after experiencing a stressful event improves cardiovascular stress recovery, which may have broader implications for long-term physical health. Additionally, when looking more closely at the content of the messages that participants wrote, analyses revealed that participants who evidenced greater prosocial sentiment demonstrated a greater downregulation of DBP and

MAP after the stressor. However, it is important to note that those in the prosocial behavior condition did not exhibit similar benefits when examining sAA, SBP and cortisol measures throughout the recovery period. While cortisol levels after the stressor followed the hypothesized direction, it is possible that there may not have been enough time points following the stressor to accurately capture differences in stress recovery amongst the groups. As for sAA, while our prior work has shown that prosocial behavior performed before a stressor reduced sAA levels (Inagaki & Eisenberger, 2016), we did not find the same effect when prosocial behavior was performed after the stressor. This may be because when examined after a stressor, this measure of sympathetic activity may no longer be increasing and so it might be harder to find effects of giving on sAA levels when examined after a stressor. Similarly, we did not find effects with SBP, which is another more proximate measure of sympathetic activity.

Interestingly, the cardiovascular findings that did show an effect were not mirrored psychologically. Those who gave to another did not report feeling less negative or more positive mood at the end of the study session (compared to the receiving and control conditions). This dissociation between psychological and physiological responding is in line previous findings in social and health psychology, which indicate that self-reported experience does not always map onto physiological responses (Egloff et al., 2002; Inagaki & Eisenberger, 2016; Kirschbaum et al., 1995). The current pattern of results is thus consistent with previous findings, which could suggest that prosocial behavior is able to alter physiology without a change in self-reported mood. In this case, the effects of prosocial behavior after stress may work under the surface, affecting physiological responses without also altering mood. However, there are other possible explanations for this finding as well.

First, it is important to note that while the main findings of Study 1 arose from differences in cardiovascular stress recovery, this was also the measure in which the most time points were collected. While cardiovascular measures were collected every 3 min and averaged according to events of the session, self-reported mood was only collected at three separate time points throughout the study—at baseline, immediately following the TSST, and at recovery. Perhaps administering more frequent assessments of mood would have illuminated differences in psychological responding due to the manipulation itself. Future research on the effects of behaving prosocially after a stressful event would benefit from including more time points to measure psychological responding, particularly in response to the manipulation itself. This may also help clarify whether there is indeed a dissociation between physiological and psychological responding, or whether these measures need to be collected in concert.

Additionally, the results of Study 2 also suggest there may be more to the story. Given that Study 2 showed that giving versus receiving led to different types of positive affect, Study 1 may have also benefitted from more specific measures of positive affect. Previous work has demonstrated a strong association between prosocial behavior and positive affect (Dunn et al., 2008), so while it is possible that prosocial versus self-rewarding behavior do not differ in broad dimensions of positive mood, they may be distinguished when examining discrete affective processes more specifically. As evidenced by the results of Study 2, administering a more precise measure of positive affect revealed that while receiving a gift card for yourself was associated with a greater experience of "wanting", giving a gift card to someone else was related to significantly greater feelings of "liking". Future studies would benefit from using these more specific assessments of positive affective states when testing the effects of prosocial behavior after stress.

Finally, the cardiovascular findings of the current study are in line with previous neuroimaging work, demonstrating the importance of caregiving neural circuitry for the stress-reducing effects of one type of prosocial behavior—support-giving. Previous work (Inagaki & Eisenberger, 2012) found that giving support to a romantic partner corresponded with increased activity in the septal area (SA) and ventral striatum (VS), neural regions critical for maternal caregiving in animals, and that the magnitude of SA activity was associated with reduced activity in the amygdala, a neural region known to be involved in threat responding. Indeed, the SA is known to have inhibitory connection to the amygdala and thus may play a role in threat reduction in order to facilitate responsive caregiving during stress (Stack et al., 2002). Because activity in the amygdala leads to increases in cardiovascular responses (Tellioglu et al., 1997), by inhibiting activation in this region, cardiovascular responses may be reduced as well. Relatedly, by giving support (engaging in prosocial behavior), one may be stimulating activity in the septal area, thereby inhibiting activation in the amygdala, and thus downregulating the physiological response when recovering from stress, which would be consistent with the findings observed in the current study. This is a potential explanation for the process by which behaving prosocially leads to a downregulated physiological stress response.

Finally, while we are confident with the results of the current work, there are limitations that are important to address particularly for future studies. First, both Study 1 and 2 were conducted on an undergraduate sample, which is important to consider when extrapolating these findings to the general population. Future work would benefit from using a more diverse sample in terms of age, location, and socioeconomic status, and interpretation of the results should consider this. Additionally, while participants in the giving group were given the option to select whomever they wanted to send a gift card to, we did not collect information regarding the nature of the relationship between the giver and receiver. Thus, we were unable to conclude whether effects might be stronger depending on the nature of the relationship. Future work should assess this in order to further explore how these effects may change (or not) when considering closeness to the recipient (for example, family member vs romantic partner vs friend). Given that we did not explicitly measure the relationship between giver and receiver, it is also possible that being told to choose a gift card for someone else may have prompted participants to think of their loved one more broadly, which may be enough to buffer against the effects of stress on its own (although the presence of a friend during the TSST has been shown in some cases to amplify rather than reduce cardiovascular responding; Allen et al., 1991). While this possibility is important to consider, we did not prompt participants to select a loved one to send a gift card to, making it less likely to explain the full effect of the manipulation.

Together, these findings suggest that engaging in prosocial behavior after stress leads to a greater downregulation of the cardiovascular response compared to engaging in self-rewarding behavior. The results of this study are in line with previous research uncovering the physical and mental health benefits of giving to others, adding experimental evidence to the body of literature on the positive effects of prosocial behavior on health and well-being.

AUTHOR CONTRIBUTIONS

Lee Lazar: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Supervision; Validation; Visualization; Writing-original draft; Writing-review & editing. **Naomi Ilana Eisenberger:** Conceptualization; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Writing-original draft; Writing-review & editing.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website. Supplementary Material

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