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Taking one for the team: Physiological trajectories of painful intergroup retaliation

Elizabeth M. Niedbala[a,*], Zachary P. Hohman[a], Breanna N. Harris[b], Alexandra C. Abide[a]

[a] Department of Psychological Sciences, Texas Tech University, MS 2051, Lubbock, TX 79409, USA
[b] Department of Biological Sciences, MS 3131, Texas Tech University, 2901 Main Street, Lubbock, TX 79409, USA

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ABSTRACT

Retaliating against a threatening outgroup offers group members specific rewards, such as restored group esteem, a reduction in anger, and a sense of gratification. Because retaliation is rewarding, group members may appraise an attack on the outgroup to be beneficial, even if it feels physically painful. We hypothesized that group members would be more willing to endure pain to retaliate against a threatening outgroup, and that appraising the painful retaliation as rewarding would down-regulate their physiological stress response to pain. Participants were manipulated to feel threatened by a rival group and then completed the cold-pressor. During the cold-pressor, participants either retaliated against the outgroup or not. Results showed that retaliation inhibited physiological responses to pain, alleviated intergroup anger, and felt less aversive. We propose that these responses are caused by a cognitive reappraisal of pain, where painful retaliation is expected to be rewarding instead of threatening.

1. Introduction

Making painful sacrifices for one's group during intergroup violence is common—rioters risk physical assault, fire hoses, and pepper spray while opposing law enforcement; infantrymen expose themselves to open fire when attacking enemies; and gang members retaliate against rival groups, fully aware that the confrontation could end in injury or death. While many factors are involved in intergroup violence, one variable that may drive angry group members to make painful sacrifices for their group is the satisfaction felt from harming their target. Group members may cognitively appraise the painful confrontation as rewarding, which may, in turn, decrease their physical experience of pain. The current study tests a novel hypothesis that when retaliating against a threatening outgroup, group members *choose to endure more pain* and actually *feel less of it*.

1.1. Retaliation

Identifying with a social group offers many benefits, one of which is a source of self-esteem for group members [3, 48]. However, outgroups can damage group member esteem through threats that undermine the group's reputation, honor, or identity [47]. Social identity threats hurt at both the group and the personal level [44], and one way to restore damaged esteem is to respond aggressively in retaliation [7, 12]. In addition to damaged esteem, outgroup threats also cause group-level anger and a motivation to approach, confront, or attack the outgroup in retaliation (i.e., approach motivation; [34, 35]). Research demonstrates that after successfully retaliating, intergroup anger and the motivation to approach the outgroup discharge [35]. The process by which retaliation alleviates intergroup anger and approach motivation is referred to as the regulatory function of intergroup anger [35].

In addition to a reduction in anger and restored esteem, acts of aggression toward the outgroup feel satisfying [35, 36]. Using fMRI data, Chester and DeWall [10] demonstrated that the nucleus accumbens was more active during retaliatory aggression vs. non-retaliatory aggression, suggesting that retaliatory behavior was rewarding. Studies also show that group members report feeling satisfied after witnessing an outgroup's misfortune [9, 13, 21, 29], or when retaliating against a threatening outgroup [35, 36].

Retaliation, then, offers significant emotional rewards, including restored group esteem, reductions in anger, and feelings of satisfaction. It is unclear, however, if these rewards drive group members to endure more extreme, risky, or harmful conditions when attacking the outgroup. Particularly, research has not yet empirically tested how much physical pain group members are willing to endure when retaliating against a rival outgroup. The current experiment will test this

* Corresponding author.
E-mail addresses: elizabeth.niedbala@ttu.edu (E.M. Niedbala), zachary.hohman@ttu.edu (Z.P. Hohman), breanna.n.harris@ttu.edu (B.N. Harris), alexandra.abide@ttu.edu (A.C. Abide).

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hypothesis for the first time while considering a mechanism that could inhibit the pain experienced from retaliation: cognitive appraisal.

1.2. Cognitive appraisal

Physical pain is extremely distressing to humans, causing intense physiological stress responses (e.g., sympathetic nervous system and hypothalamic-pituitary-adrenal [HPA] axis activation) and pain avoidant-behaviors (e.g., withdrawal). These responses facilitate an effective response to danger [26]. Even though humans are biologically programmed to avoid pain, group members continue to endure pain to attack hated groups [11]. One possible explanation for this behavior is that the emotional rewards earned during the attack (reduction in anger, increased satisfaction) cause group members to appraise the pain as rewarding, making them more willing to “take one for the team”.

Cognitive appraisal is a top-down process that describes how a stimulus is interpreted [5]. An individual can perceive the same stimulus to be harmful or beneficial, altering the trajectory of their physiological stress response [28]. For example, Speisman et al. [45] demonstrated that cognitively appraising a stressful stimulus as less aversive decreased one's autonomic stress response to it. In their experiment, participants watched video footage of adolescent boys undergoing a painful ritualistic procedure (subincision) that, normally, is highly disturbing and causes significant physiological stress for the viewer. However, in one condition the video soundtrack emphasized that the ritual was a positive and prideful experience for the boys and deemphasized the painful nature of the procedure. Appraising the ritual as beneficial, versus threatening, led to significantly lower skin conductance. Other research shows that reappraisal decreases diastolic blood pressure when being verbally harassed [46], decreases startle response magnitude and corrugator activation while viewing unpleasant images [22], and that reappraisal is overall an effective method of regulating negative emotion in response to aversive events [18]. Because attacking the outgroup relieves anger and feels gratifying, group members may expect painful retaliation to be rewarding. Reappraising the painful confrontation as beneficial instead of harmful would then down-regulate the physiological stress response to pain and decrease the subjective experience of pain during retaliation.

1.3. The current study

The current study tested if the expected rewards derived from retaliation alter a group member's pain endurance and their physiological response to it. In a between-groups experimental design, participants were told that they would be participating in a competition against a rival university and that the goal of the competition was for one's own university to have the most points at the end of the semester. All participants were manipulated to feel threatened by the rival university and were then randomly assigned to one of two conditions. In the *retaliation* condition, participants could subtract points from the rival university by completing a painful task (the cold-pressor; [33]). In the *non-retaliation* condition, participants completed the cold-pressor but knew that it would not subtract points from the rival team. We predicted that compared to non-retaliation, retaliation participants would (H1) choose to endure the painful task for longer, (H2) show lower physiological stress in response to the painful task (lower skin conductance and lower cortisol concentration), and (H3) report that the painful task was less painful. We also predicted that retaliation participants would (H4) show a greater decrease in intergroup anger and approach motivation after the painful task, and (H5) report more satisfaction with the painful task.

2. Method

2.1. Participants

The Institutional Review Board at Texas Tech University approved this experiment, and all participants provided informed consent before participation. Seventy-four introductory psychology students (26 males, 48 females, $M_{\text{age}} = 19.32$, $SD_{\text{age}} = 3.07$) participated in the study for course credit. The ethnic breakdown was Black/African American (14.6%), Asian/Pacific Islander (6.8%), White/European American/Caucasian (59.2%), Hispanic/Latino (22.3%), Native American/Alaska Native (0%), Multi-racial (0%), and other (2.9%). The cold-pressor task typically causes large effects for stress (see [6, 31]), but to err on the side of caution we predicted a medium effect size ($f = 0.35$) and desired 90% power to detect our effect. For that reason, we aimed to collect 68 participants for this study, and we chose to stop data collection at the end of the semester. By the end of the semester we had collected data from 74 participants.

2.2. Materials and methods

2.2.1. Preparation

On the day of the study, we asked participants to refrain from activities that affect salivary cortisol levels (e.g., smoking, drinking caffeine). To control for the circadian rhythm of cortisol, participants were scheduled to come to the lab between 11:30 am and 3:45 pm. Before each experimental session, the experimenter prepared an ice bath for the cold-pressor task by mixing water and ice together in a 17 l plastic bin using a 1:1 ratio (2840 ml of water, 2840 ml of ice cubes). The ice water was deep enough so that an individual's hand would be completely immersed in the water when held flat on the bottom of the bin. Following previous research (e.g., [23, 50]), the experimenter confirmed that the water temperature was 4 °C using a thermometer. A new ice bath was prepared for each participant to maintain the same water temperature across participants.

When participants arrived, they completed the consent form and were asked to rinse out their mouths with water and wash their hands with warm water and soap. Once seated in the room, the participant's palm was cleaned using a sterile gauze pad and distilled water. To measure skin conductance, two electrodes were attached to the palm of the participant's non-dominant hand. Skin conductance was recorded via BioPac Systems Inc. MP150 EDA module and disposable electrodes (EL 507's), and data collection was controlled via the BioPac Systems AcqKnowledge 4.4 software. After waiting ten minutes from when they rinsed out their mouths, and after electrodes were fixed to the participants' skin, participants provided a 0.5 ml baseline saliva sample via the passive drool method. The experimenter then recorded a 5-s baseline of skin conductance. Finally, participants were seated at the computer to begin the competition portion of the study.

2.2.2. Cover story

Participants were then told that for the competition they would be competing against a lab at a rival university for points, and that the university with the most points at the end of the semester would win the competition. They were told that the competition had been underway for several weeks, and that each student who participates has the chance to contribute to his or her team's standing by completing a task that would be described later.

2.2.3. Threat manipulation

All participants were then shown an electronic message board that displayed competitive comments ostensibly written by the participants from the rival team. In reality, the comments were created by the researchers and were designed to be insulting to participants and their university (adapted from [41]). It was intended that the comments made participants angry and motivated to retaliate against the rivals (i.e., “WE WILL DESTROY YOU”).

2.2.4. Pre- cold-pressor anger and approach motivation

Participants reported how angry (angry, displeased, furious, irritated, $M = 3.50$, $SD = 1.63$, 95% CI [3.12, 3.86], $\alpha = 0.940$) they felt toward the rival university students on a scale from 1 (*not at all*) to 7 (*extremely*). They also reported how much they wanted to approach the rival students (confront, oppose, attack, $M = 3.27$, $SD = 1.48$, 95% CI [2.96, 3.61], $\alpha = 0.841$) on a scale from 1 (*not at all*) to 7 (*very much*). Items have been used in past research to measure intergroup emotions and behavior intentions [35].

2.2.5. Retaliation conditions

Next, participants were shown both teams' current scores: [Own university]: 1029 points, [Rival university]: 1108 points. It was emphasized that their own university was only behind by 79 points. Participants were then told that for the competition, they would have the opportunity to subtract points from the rival's score by completing a task. They were told that the task was to hold their hand in ice water for as long as they could—but first they had to flip a coin. If the coin landed on *heads*, then for every second they kept their hand under the water, one point would be subtracted from the rival's score (retaliation condition). If they flipped a *tails*, then they still had to complete the cold-pressor, but it would not take any points away from the rivals (non-retaliation condition). Participants then flipped the coin and held a single hand (the dominant hand) in the ice water for however long they chose (if a participant reached 3 min, the experimenter asked them to stop). While they held their hand in the ice water, they watched an electronic timer so they could see how many seconds had passed. The experimenter recorded how many seconds the participant kept their hand immersed in the water. Skin conductance was recorded during the cold-pressor task on their non-dominant hand. After they took their hand out of the water and dried it off with paper towels, participants returned to the computer to complete a series of self-report questions.

2.2.6. Self-reported pain

On a scale from 1 (*no pain*) to 10 (*intense pain*), participants were asked to indicate the amount of pain they experienced the moment they removed their hand from the water ($M = 5.76$, $SD = 2.41$, 95% CI [5.18, 6.24]).

2.2.7. Satisfaction during the task

On a scale from 1 (*not at all*) to 7 (*extremely*), participants reported how satisfied they felt during the cold-pressor task ($M = 2.51$, $SD = 1.49$, 95% CI [2.12, 2.93]).

2.2.8. Post cold-pressor anger and approach motivation

Participants completed the same anger (angry, displeased, furious, irritated, $M = 2.89$, $SD = 1.69$, 95% CI [2.52, 3.25], $\alpha = 0.956$) and approach motivation items (confront, oppose, attack, $M = 2.96$, $SD = 1.58$, 95% CI [2.62, 3.29], $\alpha = 0.863$) as before.

Participants then answered demographic questions and let the experimenter know when they were done with the questionnaires. Twenty minutes after finishing the cold-pressor task, participants provided another 0.5 ml saliva sample (they played Solitaire on an iPad while they waited). Finally, participants were debriefed and thanked for their participation.

Baseline and post-task salivary samples were assayed in duplicate for concentration of cortisol using commercially available enzyme immunoassay kits (cortisol: 1–3002) as per the manufacturer's instructions (Salimetrics, Carlsbad, CA) and as we have done previously [20]. Saliva for cortisol was run in 5 plates; samples from the same individual were always run in the same assay plate. Sample duplicate coefficient of variation (CV) values were all under 10%. Kit-provided controls were run in each assay plate, intra- and inter-assay CVs were $< 10\%$ and $< 15\%$, respectively.

2.2.9. Control condition

A hanging control condition ($N = 29$) was included to collect normal responses to the cold-pressor without the influence of the competition cover story (7 males, 22 females, $M_{age} = 18.97$, $SD_{age} = 1.24$). Control participants were told that the study was investigating pain tolerance and that we were curious about an individual's normal responses to pain. Participants were asked to hold their hand in a cold-pressor for as long as they could (if a participant reached 3 min, the experimenter asked them to stop) while immersion time, skin conductance, salivary cortisol, and self-reported pain were collected using the same procedures as in the experimental conditions. Control participants did not complete the satisfaction, intergroup anger, or approach motivation items because they were told nothing about the rival university or competition portion of the study.

3. Results

3.1. Descriptive statistics

The total sample size for the current study was $N = 103$: seventy-four experimental participants (43 retaliation, 31 non-retaliation), and 29 hanging control participants. Because previous research has found ethnic differences in thermal pain tolerance [14], we ran a chi-square test for independence to test the relationship between condition (retaliation, non-retaliation, control) and self-reported ethnic identity (Black/African American, Asian/Pacific Islander, White/European American/Caucasian, Hispanic/Latino, Native American/Alaska Native, Multi-racial, other). Ethnic identities were not distributed significantly differently across conditions, $\chi^2(16) = 12.35$, $p = .720$. Participant sex (male, female) was also not distributed significantly differently across conditions, $\chi^2(2) = 1.47$, $p = .479$.

3.2. Hand immersion time

Hand immersion time was compared between the retaliation, non-retaliation, and control group. A one-way ANOVA revealed a significant effect for condition on hand immersion time, $F(2, 100) = 4.36$, $p = .015$, $\eta_p^2 = 0.080$. Participants in the non-retaliation condition held their hand in the water for significantly less time ($M = 67.71$ s, $SE = 10.20$s, 95% CI [47.48, 87.94]) compared to those in the retaliation condition ($M = 102.21$ s, $SE = 8.66$ s, 95% CI [85.04, 119.38], $p = .011$) and compared to those in the control condition ($M = 105.62$ s, $SE = 10.54$ s, 95% CI [84.71, 126.53], $p = .011$). Participants in the retaliation and control condition did not significantly differ from one another in hand immersion time ($p = .803$).

Thus, retaliation participants endured the cold-pressor task for significantly longer than the non-retaliation participants, as predicted in Hypothesis 1. However, we intend to interpret these results with caution. Because there was no difference in immersion time between retaliation participants and the control condition, we cannot conclude that retaliation caused participants to endure pain for significantly longer than a normal sample of individuals. Rather, we presume that the non-retaliation participants chose to end the cold-pressor task earlier than the other conditions out of disinterest or frustration.

3.3. Skin conductance

Skin conductance level was compared between the retaliation, non-retaliation, and control group. Skin conductance was recorded in microsiemens (μS) via AcqKnowledge at a rate of 1000 samples per second; data were re-calculated per second. Skin conductance level was measured following the standard method in the field, described in Lang et al. [27]. Skin conductance data was calculated per second and change scores were created for each time point by subtracting the average of the five-second baseline. Change scores are advantageous when reporting skin conductance level because it normalizes the data and avoids any of the confounds of individual variance [25]. A multilevel regression analysis was conducted to estimate the effects of condition and time on skin conductance. The data had a three-level hierarchical structure, skin conductance (in seconds) were nested within persons and persons were nested within experimental condition. The analysis was conducted using proc. mixed in SAS v9.4, using an unstructured covariance structure and treating time and participants as random factors. Additionally, we entered immersion time as a third level covariate to control for the time participants held their hand in the ice bath. We computed several models (starting with a random intercept only model) and worked up to the full factorial model, and we then compared AIC to determine the best fitting model. The best fitting model for the data (reported below) was predicting skin conductance using condition, main effect of time, time as a quadratic function, main effect of time by condition interaction, and entering the quadratic time by condition interaction. To estimate the models, we used maximum likelihood estimation with robust standard errors [42]. Maximum likelihood (ML) estimation with robust standard errors results in standard errors that are robust to non-normality [42]. Additionally, ML was used in the estimation of missing data, because not all participants kept their hand in the water for 180 s. Estimating missing data using maximum likelihood is considered preferable to older procedures (e.g., listwise deletion), even when certain assumptions (e.g., the data are missing at random) are not met (see [17]).

There was both a significant linear ($b = -0.028$, $SE = 0.002$, 95% CI [-0.032, -0.025], $F(1, 9172) = 404.23$, $p < .001$) and quadratic ($b = 0.00011$, $SE < 0.001$, 95% CI [0.0001, -0.00012], $F(1, 9172) = 173.72$, $p < .001$) effect of time on skin conductance. There was no main effect for condition ($F(2, 97) = 0.68$, $p = .508$), however, there was a significant condition by quadratic time interaction ($F(2, 9172) = 25.70$, $p < .001$), see Fig. 1 (see supplemental document for a figure of the raw data). Examination of the simple slopes indicated that the quadratic relationship between time and skin conductance was significant for the retaliation ($b = 0.0001$, $SE < 0.001$, 95% CI [0.00008, 0.00012], $F(1, 9172) = 12.41$, $p < .001$) and control conditions ($b = 0.00012$, $SE < 0.001$, 95% CI [0.0001, 0.00014], $F(1, 9172) = 12.60$, $p < .001$), but was not significant for the non-retaliation condition ($b < 0.0001$, $SE < 0.001$, 95% CI [-0.000001, 0.00004], $F(1, 9172) = 0.95$, $p = .340$). Comparing the quadratic slopes among the three conditions indicated that the quadratic slope for the retaliation condition was significantly larger (further from zero, either positive or negative – sign indicated direction of quadratic relationship) than the non-retaliation condition ($b = -0.0009$, $SE < 0.001$, 95% CI [-0.0012, -0.00006], $F(1, 9172) = -5.93$, $p < .001$) and there was a nonsignificant marginal trend suggesting a smaller quadratic slope than the control condition ($b < 0.0001$, $SE < 0.001$, 95% CI [-0.0000003, 0.0000005], $F(1, 9172) = 1.71$, $p = .087$). The control condition had a significantly larger quadratic slope than the non-retaliation condition ($b = 0.0001$, $SE < 0.001$, 95% CI [0.00008, 0.00014], $F(1, 9172) = 6.95$, $p < .001$).

These results suggest that the retaliation condition had an initial decrease in skin conductance from baseline, and skin conductance continued to decrease over time and increased at the end. Overall, the pattern of our results supports Hypothesis 2, although the main effect for condition did not reach significance. The retaliation condition showed the greatest decrease in skin conductance from baseline, while the non-retaliation and control participants showed very little change from baseline.

3.4. Salivary cortisol

Cortisol concentration was compared between the retaliation, non-retaliation, and control group. Due to monetary restrictions, only 19 out of the 29 control participants were assayed (4 males, 15 females). Control participants were selected for assay via a random number generator. Cortisol concentration is reported as micrograms of hormone per deciliter of saliva (μg/dl). Output data was log10-transformed to improve normality as sample distribution was positively skewed; back-transformed data are reported for ease of interpretation. Participant sex, sample time of day, and hand immersion time were used as covariates in the analyses.

To evaluate changes in cortisol from pre- to post-cold-pressor, we conducted a repeated measures ANCOVA with pre/post base-10 logged cortisol as the repeated factor, condition as the independent variable, and controlled for time of day, participant sex (known covariates for cortisol) and hand immersion time. Results uncovered a significant cortisol X condition interaction, $F(2,87) = 3.90$, $p = .024$, $\eta^2 = 0.082$, see Fig. 2. Looking at the change in cortisol from pre- to post cold-pressor for each condition, there was a significant increase in cortisol for the non-retaliation condition, ($M_{pre} = 0.251$, $SE = 0.051$, 95% CI [0.199, 0.318] vs. $M_{post} = 0.303$, $SE = 0.048$, 95% CI [0.243, 0.378]), $F(1,87) = 4.98$, $p = .028$, $\eta^2 = 0.054$, and a significant increase for the control condition, ($M_{pre} = 0.185$, $SE = 0.065$, 95% CI [0.137, 0.249], vs. $M_{post} = 0.254$, $SE = 0.061$, 95% CI [0.192, 0.336]), $F(1,87) = 8.78$,

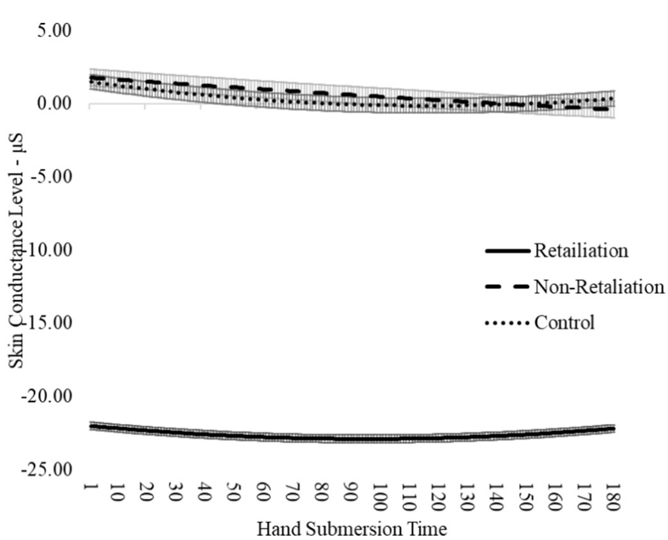

Fig. 1. Change in skin conductance from baseline during cold-pressor. The retaliation condition showed the strongest decline in skin conductance from baseline compared to the non-retaliation and control conditions. Error bars represent standard error.

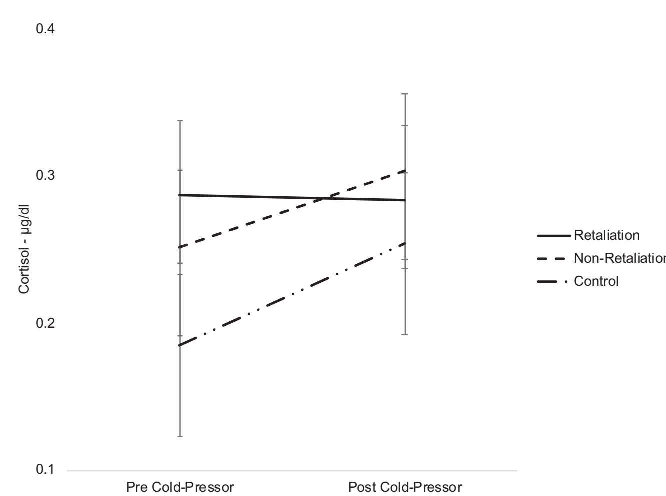

Fig. 2. Change in cortisol concentration from pre- to post cold-pressor task. The non-retaliation and control conditions showed a significant increase in cortisol and the retaliation condition showed no significant change. Error bars represent standard error.

$p = .004$, $\eta^2 = 0.092$, but no change in cortisol for the retaliation condition ($M_{pre} = 0.287$, $SE = 0.042$, 95% CI [0.237, 0.348], vs. $M_{post} = 0.284$, $SE = 0.040$, 95% CI [0.237, 0.340],), $F(1,87) = 0.03$, $p = .865$, $\eta^2 < 0.001$.

The cortisol data provide strong supporting evidence for Hypothesis 2. The control and non-retaliation participants showed a significant spike in cortisol indicating a distressing response to the cold-pressor (as is typical in cold-pressor studies, see [1, 15, 43]), while the retaliation participants showed *no change* in cortisol concentration. At the neuroendocrine level (HPA axis), retaliating against a threatening outgroup in a painful manner does not produce the stress response typically associated with physical pain.

3.5. Self-reported pain

Self-reported pain was compared between the retaliation, non-retaliation, and control group. A one-way ANCOVA tested the effect of condition on self-reported pain while co-varying hand immersion time. The omnibus test revealed a nonsignificant marginal trend, $F(2, 98) = 2.57$, $p = .081$, $\eta_p^2 = 0.050$, and planned post-hoc comparisons showed a significant difference between the control condition and retaliation condition. Participants in the control condition reported significantly less pain ($M = 4.62$, $SE = 0.424$, 95% CI [3.78, 5.47]) compared to the retaliation condition ($M = 5.85$, $SE = 0.343$, 95% CI [5.17, 6.53], $p = .026$). Self-reported pain did not differ between the non-retaliation condition ($M = 5.49$, $SE = 0.412$, 95% CI [4.67, 6.31]) and the control condition ($p = .152$), or between the non-retaliation condition and the retaliation condition ($p = .512$).

Hypothesis 3 was not supported. Even though retaliation participants showed signs of lower physiological stress during the cold-pressor, they did not report less subjective pain compared to non-retaliation participants. Surprisingly, the control condition reported significantly less pain than retaliation participants, an unexpected finding that we consider in the general discussion.

3.6. Intergroup anger

Anger toward the outgroup was compared between the retaliation and non-retaliation conditions. A mixed ANOVA was conducted on intergroup anger with time as the within-subjects factor (pre- vs. post task) and condition as the between-subjects factor (retaliation vs. non-retaliation). The between-subjects effect of condition on intergroup anger was not significant, $F(1, 72) = 0.628$, $p = .431$, $\eta_p^2 = 0.009$, but there was a significant main effect for time, $F(1, 72) = 14.23$, $p < .001$, $\eta_p^2 = 0.165$, such that participants reported significantly more intergroup anger before the cold-pressor task ($M = 3.49$, $SE = 0.193$, 95% CI [3.11, 3.88]) than after the task ($M = 2.94$, $SE = 0.197$, 95% CI [2.55, 3.34]). However, as predicted, the main effect for time was qualified by an interaction between time and condition, $F(1, 72) = 5.60$, $p = .021$, $\eta_p^2 = 0.072$, see Fig. 3. Participants in the retaliation condition showed a significant decrease in intergroup anger from pre- to post task ($M_{Diff} = -0.891$, $SE_{Diff} = 0.188$, 95% CI [−1.27, −0.517], $p < .001$). Non-retaliation participants showed no difference in intergroup anger from pre- to post task ($M_{Diff} = -0.204$, $SE_{Diff} = 0.221$, 95% CI = [−0.646, 0.237], $p = .359$).

This finding supports Hypothesis 4 and the regulatory function of intergroup anger. Group members' anger toward the outgroup decreased only if they retaliated. Because these data replicate past research on retaliation [35], we can be reasonably confident that participants were differentially appraising the cold-pressor task, as intended.

3.7. Approach motivation

The desire to approach (confront, oppose, attack) the outgroup was compared between the retaliation and non-retaliation conditions. A mixed ANOVA was conducted on approach motivation with time as the within-subjects factor (pre- vs. post task) and condition as the between-subjects factor (retaliation vs. non-retaliation). The between-subjects effect of condition was not significant, $F(1, 72) = 0.052$, $p = .820$, $\eta_p^2 = 0.001$, but there was a significant main effect for time, $F(1, 72) = 8.47$, $p = .005$, $\eta_p^2 = 0.105$, where participants reported significantly more approach motivation before the cold-pressor task ($M = 3.26$, $SE = 0.176$, 95% CI [2.91, 3.61]) than after the task ($M = 2.98$, $SE = 0.187$, 95% CI [2.61, 3.36]). Again, as predicted, this main effect was qualified by an interaction between time and condition, $F(1, 72) = 4.98$, $p = .029$, $\eta_p^2 = 0.065$, see Fig. 4. Participants who retaliated significantly decreased in approach motivation from pre- to post task ($M_{Diff} = -0.488$, $SE_{Diff} = 0.123$, 95% CI [−0.734, −0.243],

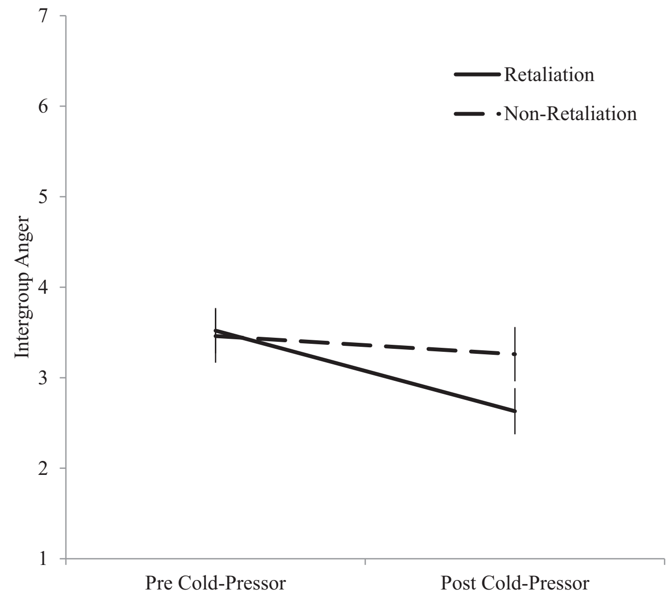

Fig. 3. Change in anger toward the outgroup from pre- to post-cold-pressor task. The retaliation condition showed a significant decrease in self-reported intergroup anger and the non-retaliation condition showed no significant change. Error bars represent standard error.

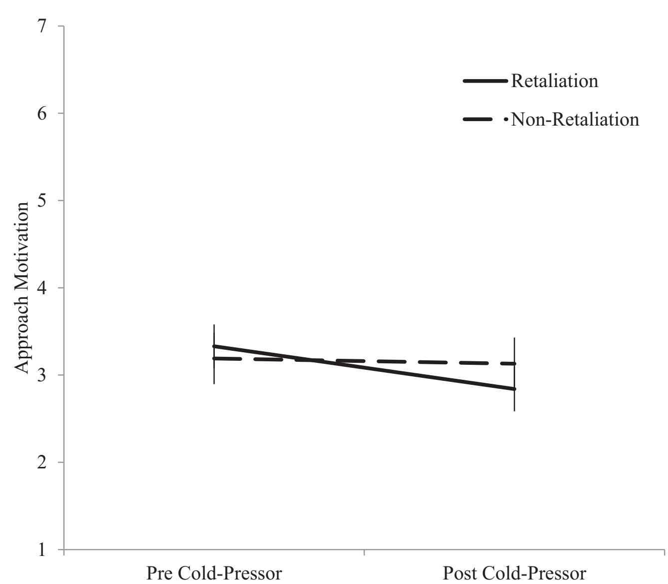

Fig. 4. Change in approach motivation toward the outgroup from pre- to post-cold-pressor task. The retaliation condition showed a significant decrease in self-reported approach motivation toward the outgroup and the non-retaliation condition showed no significant change. Error bars represent standard error.

$p < .001$). There were no changes in approach motivation from pre- to post task for non-retaliation participants ($M_{\text{Diff}} = -0.065$, $SE_{\text{Diff}} = 0.145$, 95% CI [−0.353, 0.224], $p = .657$).

As predicted, participants reported significantly less motivation to approach the outgroup after retaliating against them. Again, this finding supports Hypothesis 4, that group members' desire to approach (oppose, confront, and attack) the outgroup decreased only if they retaliated. Additionally, this evidence bolsters our confidence that the two retaliation conditions were appraising the cold-pressor task differently.

3.8. Satisfaction during the task

Satisfaction with the retaliation task was compared between the retaliation and non-retaliation conditions. An independent samples *t*-test revealed that non-retaliation participants reported significantly less satisfaction during the cold-pressor task ($M = 2.00$, $SD = 1.55$, 95% CI [1.50, 2.59]) than retaliation participants ($M = 2.88$, $SD = 1.83$, 95% CI [2.34, 3.44]), $t(72) = 2.18$, $p = .032$, $d = 0.520$. It should be noted that satisfaction scores were significantly below the midpoint of the scale (test value = 4.00, $t(73) = -17.83$, $p < .001$), meaning that the task was relatively dissatisfying for all participants. Because of this, it is difficult to claim that the retaliation participants felt significantly *more satisfied* during the cold-pressor compared to non-retaliation participants. Instead, it is more appropriate to describe retaliation participants as feeling significantly *less dissatisfied* than non-retaliation participants. Nonetheless, in testing Hypothesis 5, we found that retaliating against the outgroup can decrease the aversiveness of a painful task.

4. Discussion

This experiment tested a novel hypothesis that retaliating against a threatening outgroup would cause group members to appraise a painful confrontation as rewarding. In turn, we expected that reappraising the painful retaliation to be beneficial instead of harmful would down-regulate group members' stress response and subjective experience of pain.

Examining the findings for Hypothesis 1, retaliation participants endured the cold-pressor for significantly longer than the non-retaliation participants. However, we presume that non-retaliation participants were less interested with the task because they knew it would not subtract points from the outgroup. Surprisingly, there was no significant difference in hand immersion time between retaliation and control participants. An oversight in our research design was that the retaliation participants were told that they were 79 points behind the outgroup, possibly causing them to use this information as a reference for how long they should attempt the task (or as a goal to reach). Control participants received no information that could have been used as an anchor. Examining the distribution of immersion times between conditions, there was a spike in the number of retaliation participants who ended the cold-pressor closely after 79 s. For instance, 20.8% of retaliation participants and 0% of control participants ended the task between 79 and 100 s. If retaliation participants had been unaware of the team scores, perhaps they would have endured the painful task for longer overall. Future research should test the length of time group members choose to endure pain using a task that does not require a cutoff time and without the influence of anchoring information.

Using two different measures of physiological stress, we found support for Hypothesis 2. The skin conductance data showed that retaliation participants' skin conductance initially decreased from baseline and continued to decrease over time, and then increased at the end. As predicted, participants who retaliated showed the greatest declines in skin conductance from baseline compared to non-retaliation and control participants. Additionally, the cortisol data showed clear differences in reactivity between conditions. Non-retaliation and control participants showed significant, hormonal stress responses to the cold-pressor, while retaliation participants showed no response. Thus, our data suggest that appraising the painful task as rewarding alters one's physiological response to a painful task. To our knowledge, this is the first study to show that outgroup retaliation prevents painful task-induced increases in cortisol. We hypothesize this effect may be mediated by the brain's mesocorticolimbic dopamine reward system (i.e., the nucleus accumbens, ventral striatum, ventral tegmental area, amygdala, and prefrontal cortex; [24]). This brain system is not only activated by classical rewards (i.e., food, sex, and drugs; [51]), but also by listening to pleasant music [38] and by rewarding emotions, such as humor [39]. Intriguingly, rodent studies show natural reward and concomitant activation of the brain reward system dampens the HPA axis response to stress [49]. Moreover, recent human fMRI data show that during retaliatory aggression vs. non-retaliatory sessions, the nucleus accumbens was more active, suggesting that retaliatory behavior was rewarding [10]. Thus, we predict that when our participants appraised the painful retaliation task as rewarding, this cognitive shift activated the brain reward pathway and damped the physiological stress response. Future research should test this hypothesis.

An alternative explanation for the cortisol data that should be considered is that the retaliation condition showed a ceiling effect. It is possible that the slightly elevated baseline levels in the retaliation group prevented the cold-pressor task from increasing cortisol further. However, we do not believe that this is the case for the current data, as previous research using similar cold-pressor methods (e.g., same task duration, time of day, and assay kit) show that the cold-pressor can push salivary cortisol levels higher than those measured in the current study (see [19, 32, 37]). Nonetheless, future research should replicate the current study to clarify the relationship between painful outgroup retaliation and cortisol reactivity.

Even though retaliation participants experienced lower physiological stress during the cold-pressor, they reported the same amount of pain as non-retaliation participants and significantly higher pain than the control group. Thus, Hypothesis 3 was not supported. There are two possible explanations for this pattern of results. First, a counterintuitive finding in cold-pressor studies is that participants who are distracted during the cold-pressor report *more* pain than those who focus on the painful sensations [4, 30]. In our research, retaliation participants were likely paying more attention to the stopwatch than to the sensations in their hand, because the number of seconds that passed was directly relevant to the number of points they were subtracting from the outgroup. Control participants had no reason to closely monitor the stopwatch, making them more likely to focus on the pain. If this were true, then our findings would be congruent with previous research showing that distracted participants report more pain than those attending to the sensations in their hand. A second possible explanation could be the role of stress-induced analgesia, as typically stress is associated with a decrease in pain [8]. Our retaliation group did not show an increased physiological stress response to the cold-pressor and thus may not have benefitted from the pain-reducing effects of the stress. This idea is supported by other research where individuals who showed blunted salivary cortisol response to the cold-pressor showed greater pain than individuals with higher cortisol [2]. However, not all studies have found similar results with cortisol response and pain [16, 40], thus this topic should be investigated further. Regardless, our study did not confirm that retaliation makes an attack subjectively *feel less painful.*

Retaliation, however, does feel more emotionally rewarding. Supporting Hypothesis 4, we found that retaliating against a threatening outgroup significantly decreased participants' anger and approach motivation, replicating previous research on the regulatory function of intergroup anger [35]. Also corroborating previous retaliation research [35, 36], in testing Hypothesis 5 we found that retaliating against the outgroup was significantly less dissatisfying than not retaliating. For the first time, our experiment shows that even painful retaliation yields emotional rewards, providing more insight into why group members willingly put themselves in harm's way to attack the outgroup. Beyond our findings on the emotional benefits of retaliation, this experiment highlights a mechanism that may further motivate group members to endure painful attacks—an inhibited stress response.

One limitation in our research was that we did not explicitly manipulate cognitive appraisal. We relied on previous research demonstrating that group members perceive retaliation to be rewarding, but we did not manipulate or measure participants' appraisal of the cold-pressor task. Future research should more directly alter group members' perceptions that their attack is harmful or rewarding. Another limitation of our experiment was the low external validity of our retaliation task. Subtracting points from another team does not represent a real-life attack against the outgroup. Our hypotheses should be tested under more realistic conditions, such as in military training. However, the basic nature of our experiment uncovered a novel relationship between retaliation, appraisal, and physiological stress, which we hope will motivate additional research on this topic.

4.1. Conclusions

Altogether, this experiment shows that retaliating against a threatening outgroup inhibits one's physiological response to pain, alleviates intergroup anger, and feels less aversive. We propose that these responses are caused by a cognitive reappraisal of pain, where painful retaliation is appraised as rewarding instead of threatening. This study extends previous retaliation research by showing that even painful retaliation against a rival outgroup yields emotional rewards, and we demonstrate for the first time that retaliation can inhibit the neuroendocrine response to physical pain. These findings introduce the possibility of an additional mechanism driving retaliation—inhibited stress responses—refining our understanding of intergroup violence and self-sacrificing behavior following outgroup threat.

Declarations of interest

None.

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