The Effect of Physical and Social Pain on Helping Behavior

by

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Certificate of Approval

This is to certify that the accompanying thesis by Ben Litwick Lahr and Gabriel Weil Zansberg has been accepted in partial fulfillment of the requirements for graduation with Honors in Psychology.

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Table of Contents

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Abstract

Neural imaging suggests an overlap between the brain's response to physical and social pain. If physical and social pain overlap in underlying neural circuitry, it is possible that both types of pain have similar behavioral consequences. By using two well-known pain manipulations, we investigated how physical and social pain affected helping behavior. The Cold Pressor Test was used to manipulate physical pain. Participants immersed their non-dominant forearm in ice-cold water for up to three minute to cause pain. Cyberball, a computerized simulation of social ostracism, was utilized to induce social pain. Participants in the painless control group recalled a typical Thursday. After the pain manipulation, researchers subtly knocked over a cup of pencils onto the floor as they handed a post-test questionnaire to the participant, and the participant's helping behavior was measured. Based on the martyrdom effect, we hypothesized that physical and social pain would lead to significantly more helping behavior than the control group. Based on social pain overlap theory, we also expected the physical and social pain groups to not differ significantly. Our data trended in the hypothesized directions. However, no group differences were significant. We were unable to support or refute either social pain overlap theory or the martyrdom effect, and we suggest that future researchers either use different methods to measure helping behavior or choose a behavior with fewer experimental confounds.

Keywords: altruism, physical pain, social pain, martyrdom effect, helping

List of Figures

Introduction

Pain is a fundamental experience that can appear both physically and socially. While physical pain is oftentimes more observable (i.e. a pain response to a broken bone), it is common to describe social pain similarly, using overlapping terms and descriptions (i.e. a broken heart) despite some important differences.

While pain is unpleasant and can be a nuisance, it serves some important functions. Some of the usefulness of pain is strictly biological and serves to facilitate healing. The soreness that accompanies an injury causes us to use the damaged body part with care and prevent activities that could impede the healing process or lead to additional damage (Buckwalter & Hunziker, 1996). In some social species, the function of pain may go beyond recuperation and inform social interactions.

Pain is an essential component in learning, as a frequent consequence in both positive punishment and negative reinforcement. Positive punishment involves the application of an aversive stimulus after the performance of an undesired behavior, leading to a decrease in the performance of that behavior (Domjan, 2010). Pain is a fundamental aversive stimulus; it sends the signal that the behavior that led to harm or vulnerability should be avoided. For example, a person touches a hot stove burner and immediately feels intense pain. In the future, this person will check twice, maybe three times, before touching a burner. Alternatively, negative reinforcement involves the removal of a painful stimulus to increase a behavior (Navratilova et al., 2012). For instance, Stephens & Umland (2011) found that swearing in response to physical pain decreases the strength of the pain. Swearing decreases pain, which reinforces swearing in response to pain in the future.

Being able to perceive and respond to pain helps mammals both lessen their own pain and alert others of personal struggles (Panksepp, 2004).Without brain mechanisms designed to both sense and announce the feeling of pain, individuals with severe injuries risk being left on their own in a vulnerable state. Although injuries and the expression of pain makes one vulnerable, being able to alert others of pain can carry a principal evolutionary advantage, particularly for social animals. Selfish gene theory (Dawkins, 1976) is a gene-centered view of evolution that explains social behavior as genes doing what is effective for their own survival. It posits that animals are motivated to invest in the survival of their kin ultimately because of their genetic similarities. Though an individual may have more access to resources without kin competition, the death of a related individual reduces copies of their own genes. Thus, a vulnerable individual may be motivated to help kin even at their own expense. This poses a risk to the vulnerable individual, as their help may not be returned, but could still result in a net increase in gene copies.

Physical Pain

Williams (2002) showed that humans respond to physical pain (i.e. soft-tissue wounds) by avoiding similar situations in the future, an instance of positive punishment. In addition, they may limit exposure to potentially dangerous situations, an instance of avoidance learning linked to negative reinforcement. As a result of these basic learning consequences, humans learn to accurately calculate risk before acting, limiting many high-risk activities. Unfortunately, pain is inherently subjective and only available to the perceiver. Understanding the mechanisms involved in responses to pain requires a consistent way of inducing and/or measuring pain.

Several researchers have employed the Cold Pressor Test (CPT) to induce the experience of physical pain (Riva, Wirth, & Williams, 2011; Victor et al., 1987). By asking participants to take pre and post CPT pain surveys, they have shown the consistent effect it has on the pain experience. The CPT, originally developed in the 1930s to assess hypertension (Hines & Brown, 1936), involves immersing a limb (usually the non-dominant forearm) into an ice bath that is between 32 and 37 degrees Fahrenheit for up to five minutes. After five minutes, most participants report an experience of moderate to severe pain. Furthermore, the CPT induces pain that seems to rely on the same neurological substrate as naturally occurring pain (Wang et al., 2019). Angst et al.'s (2012) twin study showed an increase in pain tolerance and threshold in participants who received an opioid analgesic (pain narcotic) before beginning the test. The CPT has also been effective at discerning gender differences in pain tolerance, with men having a significantly higher tolerance than women. However, men and women do not show a significant difference in pain intensity ratings (Mitchell, MacDonald, & Brodie, 2004). Thus, the CPT is a safe way to induce a consistent level of pain, and also capable of producing reliable experimental differences.

Social Pain

Social pain is the experience of pain after perceiving that interpersonal ties are weakened or cut off. Rejection, devaluation, loneliness, and ostracism are all varieties of social pain. Social pain can lead to internal consequences such as a decrease in satisfaction of belongingness, self-esteem, control, and meaningfulness of existence (Williams, 2001). The psychological consequences of social pain have been shown to be more drawn out, more easily “relived,” and more painful once “relived” than physical pain (Meyer, Williams, & Eisenberger, 2015).

To operationalize social pain, Williams, Cheung, & Choi (2000) developed Cyberball, a virtual ball-tossing game that ultimately excludes the participant from a game of catch. Several researchers have since employed Cyberball in a variety of ostracism-related experiments (DeWall et al., 2010; Eisenberger, Lieberman, & Williams, 2003; Riva et al., 2011). Mapping a neural overlap between physical and social pain led Eisenberger and Lieberman (2004) to posit the Social Pain Overlap Theory (SPOT).

Social Pain Overlap Theory

While the stimuli leading to social and physical pain are quite different, social pain may rely on some of the same components of the nervous system as physical pain. Panksepp (2004) found that administering an opiate (a drug used to treat physical pain) to panicking young animals who had been separated from their mother reduced crying behavior. More recently, a considerable amount of research has shown physiological similarities between physical and social pain. Eisenberger et al. (2003) found fMRI evidence suggesting that the dorsal anterior cingulate cortex (dACC) is involved in the affectively distressing components of both physical and social pain. It should be noted that while there is overlap in the dACC, both physical and social pain also activate separate portions of the brain.

Following Eisenberger and Lieberman (2004), DeWall et al. (2010) examined SPOT by testing the effects of acetaminophen on social pain (again, via Cyberball) and found that participants who took acetaminophen showed significantly less activity in the dACC than did the participants in the control group, although both groups reported equal levels of social distress in response to social exclusion. These results suggest that acetaminophen, a drug typically used to reduce physical pain, can also reduce social pain. Riva et al. (2011) expanded on Eisenberger and Liberman's (2004) SPOT research by demonstrating that both physical and social pain similarly affect psychological variables such as satisfaction, mood, and feelings of ostracization. The aforementioned researchers suggest further investigation into behavioral overlaps between physical and social pain. These two experiences, whose sources are qualitatively different, may be more similar than not. It is possible that prior research into physical pain might generalize into social pain.

The Martyrdom Effect

The presumed adaptive function of social pain is that expression of pain may solicit help from others. However, note that help is bidirectional: one can be a recipient or a provider of help. It is counterintuitive to expect one's pain to trigger their own prosocial response. If one is in a vulnerable state due to injury, offering help to another might be especially costly. Animals in pain would likely conserve energy and attempt to attract aid from others. It is surprising, then, that Leeuwen, James, and Hamaker (2014) found that the anticipation of physical pain reduced discrimination compared to a painless control group, showing that expecting a painful experience can lead to prosocial behavior. Similarly, Olivola and Shafir (2013) have shown a correlation between one's own physical pain and their own helping behavior. The researchers asked participants to donate money to charity in order to participate in an event. Participants were more likely to donate money (and donated more money) to participate in a physically painful event (a five-mile run) than engage in a pleasurable event (attending a charity picnic). To explain this puzzling phenomenon, they posited the martyrdom effect, which states that the anticipation, rather than the experience, of physical pain leads to an increased rate of helping behavior. Research in orthodontics, a notoriously painful field, suggests that the anticipated pain associated with a root canal procedure is ranked higher than the actual pain experienced after the operation (Pak & White, 2011). If the experience of pain promotes altruism and anticipated pain appears to be more painful than the experience of pain, the martyrdom effect could be a powerful tool for promoting prosocial behavior.

Evolutionarily, pain and the anticipation of pain should lead to self-interest rather than altruism. This makes the martyrdom effect somewhat cryptic. However, reciprocal altruism may explain why animals (including people) complete behaviors for each other: because they expect to later receive benefits in return (Dawkins, 1976). From this perspective, individuals experiencing pain may be more willing to help others because they better understand the need for help, or because they are in a more dire situation, in need of all the favors they can accumulate. Their present vulnerability may also appear long lasting, and further motivates the individual to accumulate allies as soon as possible.

Social Exclusion

Having a social group to count on is beneficial to survival; however, social support is not always present, and sometimes individuals are not included. Social exclusion (a building block of social pain) can lead to psychological consequences such as depression, reduced mood, and reduced self-esteem (Williams & Nida, 2011).

Twenge et al. (2007) tested the behavioral ramifications of social exclusion using questionable methodology. After completing a questionnaire, Twenge and her team provided participants with predictions about their future, such as that they would die alone. Twenge et al. found that verbal hostility of this nature led to a reduction in prosocial behavior, inconsistent with the martyrdom effect. The experiment likely brought out an inordinate amount of fear rather than hurt. It is possible that participants viewed the manipulation as a personal attack rather than (or in addition to) social exclusion, which could account for discrepancies with the martyrdom effect.

Although Twenge et al.'s (2007) manipulation elicited emotions that were consistent with some aspects of social exclusion, they may also have increased anxiety and anger. Rather than manipulating social exclusion, it is possible that these researchers manipulated an experience more similar to social hostility. If so, then the potential benefits of prosocial behavior might not be expected: reciprocal altruism is only worth initiating with individuals you expect will reciprocate. Participants were *told* rather than *shown* that they do not belong. Cyberball offers a more accurate manipulation of social pain because participants are led to believe they are engaging with people who, for no apparent reason, exclude them. Thus, when participants are excluded, they feel social pain without the accompanying need to defend themselves from direct hostility that participants may have felt towards Twenge and her team (2007).

The Current Study

SPOT proposes that social exclusion can lead to pain that is comparable to physical pain in some ways. However, according to Amadio (2010), a neural overlap does not guarantee that physical and social pain will be expressed in the same way. Behaviors driven by pain, such as the martyrdom effect, may or may not play out in the same way in the context of physical and social pain.

Martyrdom effect theorists posit that the expectation of physical pain increases helping behavior. We tested whether recently experienced pain would also increase helping. In addition, we tested the social pain overlap theory to see if social pain also leads to an increase in helping behavior, and if the effect is comparable. We hypothesized that physical and social pain would lead to significantly more helping behavior than the control group; however, the difference between the physical and social pain groups would be negligible.

Method

Participants

We recruited 150 students from Whitman College ages 18 to 25 ($M = 20.48$, $SD = 1.42$). Our sample included 87 people who identify as men and 63 people who identify as women. No other demographic data was taken.

We used a convenience sampling strategy, recruiting via email and in person. Given an alpha of .05 and a small effect size of .29, (as achieved by Leewen et al., 2014) an a priori test of power analysis using G*Power (Faul et al., 2007) suggested that we use a sample size of at least 123 participants in order to achieve the desired statistical power of .80. Convenience sampling allowed us to recruit enough participants to achieve adequate power.

Design

We conducted a three level between-groups experiment. The independent variable was pain, manipulated into three levels: physical (induced by the Cold Pressor Test), social (induced by playing Cyberball), and a control group that was absent of pain (recalling a typical Thursday afternoon, as used by Riva et al., 2011). The dependent variable, helping behavior, was measured by recording if participants assisted the researchers in picking up fallen pencils. This was broken down into two measures: if the participant helped and how many pencils they picked up, a method used by Lefevor and Flowers (2016). We used a between-groups design to avoid participants enduring multiple levels of pain. Additionally, after participants had picked up pencils once, seemingly unrelated to our experiment, repeating a similar procedure would likely have led to hypothesis guessing.

Procedure

To minimize threats to external validity, all tests occurred in the college's library study rooms to control for setting as a confounding variable or a factor that would threaten replicability. In addition, the researcher proctoring the experiment (one of two researchers) was randomly assigned and evenly distributed across conditions. Randomly distributing researchers varied the levels of closeness between participant and experimenter, but there was almost always some familiarity due to the small student population. When asking a peer if they would like to participate in our study, we asked if they have time, informed them that our study involves the potential for temporary pain, and offered compensation (regardless of test completion) in the form of a cookie, fruit, or participation credit for introductory level psychology classes.

Upon entering the testing room participants provided informed consent, ensuring they understand that our experiment is voluntary and that they can leave at any time. Participants then partook in one of three levels of pain. Participants were evenly and randomly assigned to each level. The participants were monitored to ensure there were no extreme reactions to the physical or social pain.

Physical pain. Participants in the physical pain group undertook the Cold Pressor Test by immersing their non-dominant arm (up to the elbow) in a bucket of water that was between 32 and 37 degrees Fahrenheit for up to three minutes. The Cold Pressor Test typically took between 30 seconds and 3 minutes to induce pain. Participants were told that they should pull out their arm as soon as they experienced overwhelming discomfort.

Social pain. Participants in the social pain group played Cyberball for three minutes (equal to the ceiling for the Cold Pressor Test). Participants were each seated in front of a laptop with Cyberball already on the screen (Figure 1). The participants viewed a screen with their player (centered in the bottom of the screen) with three other, supposedly online, players (spread in a semi-circle around the participant's character). The software was programmed so each of the three computerized players threw to the participants once in the first minute to start the game and then never again for the remaining two minutes. They also had the option to 'chat' with the computerized players. Cyberball has been shown to elicit feelings of ostracism even if participants know the game is a sham.

Figure 1. Screenshot of the participant's view playing Cyberball in the social pain group.

Control. Participants in the control group orally described a normal Thursday to the researcher. Participants were cut off after three minutes, the same time as the other manipulations. When participants did not use the full time, they were asked about the specifics of their day until the three minute time quota was met.

After completing the task, participants were asked to complete a questionnaire with items regarding demographics, what they thought the experiment was testing, the level of pain induced by the manipulation, and several distractor questions. To assess the level of pain induced, we used the Faces Pain Scale-- Revised (FPS-R). The FPS-R has been shown to be as valid as other leading pain scales (Ferreira-Valente, Pais-Ribeiro, & Jensen, 2011). While handing this questionnaire to participants, the researcher intentionally, but not obviously, knocked over a cup filled with 30 wooden pencils. The experimenter muttered a phrase like, “Gosh, I’m so clumsy,” and then began picking up one pencil per second. We recorded whether or not the participant helped pick up pencils and how many pencils they picked up.

Measures

All participants who completed the experiment were included in the final data analysis. Whether participants helped by picking up pencils was a nominal variable, while the number of pencils picked up was a ratio variable.

Results

Manipulation Check

To test whether we successfully manipulated pain in our physical and social pain groups we ran a one-way between-groups ANOVA comparing pain ratings of three groups (Physical, Social, No Pain). A significant effect was seen $F(2, 149) = 116.03$, $p < .01$, $\eta^2 = .61$ (Figure 2). Participants rated the physical pain group as the most painful condition, ($M = 2.76$, $SD = 1.19$), followed by the social pain group, ($M = 0.73$, $SD = 0.92$) and the control group, ($M = 0.23$, $SD = .675$). Further, a post-hoc Tukey HSD test confirmed a significant difference between all pairs of pain groups (all *p*s < .05).

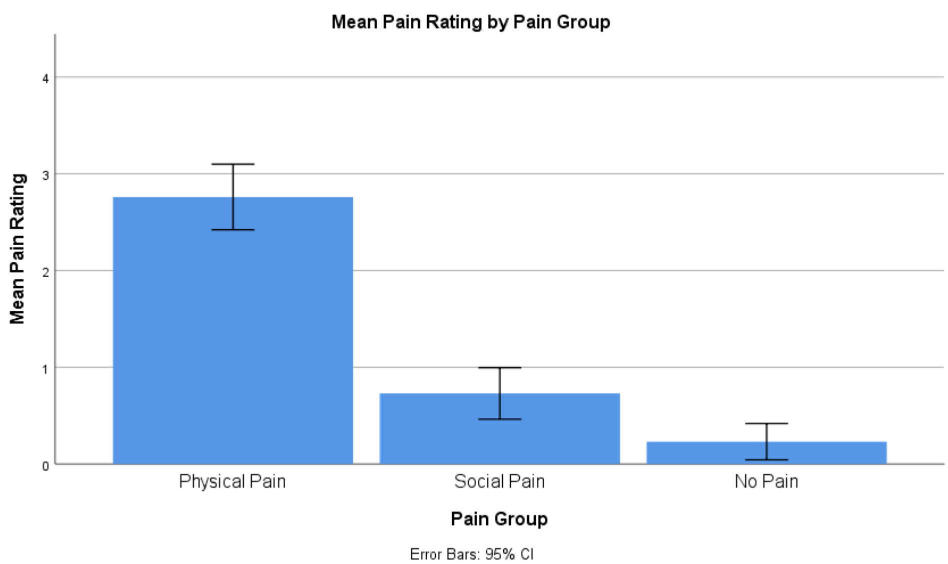

Figure 2. Bar graph showing mean pain rating by pain group. Error bars indicate 95% confidence intervals.

Tests of Hypothesized Effects

Our dependent variable was measured in two ways: if participants picked up pencils (nominal) and how many they picked up (ratio). In total, 52.7% of participants helped pick up pencils. In both pain groups, a majority of participants helped pick up pencils (56% in physical pain and 58.3% in social pain), while a minority of participants in the control group helped (44.2%).

A Chi-Squared test of independence was performed to examine the relationship between pain manipulations and whether or not participants helped pick up pencils (a nominal variable). The relationship between these variables was not significant, X^2 (2, *N* = 150) = 2.33, *p* = .31. While there was no significant relationship between pain manipulations and helping, the frequencies were consistent with our hypothesis: A majority of participants in both pain groups helped pick up pencils, and a majority of participants in the no-pain control group did not help (Figure 3).

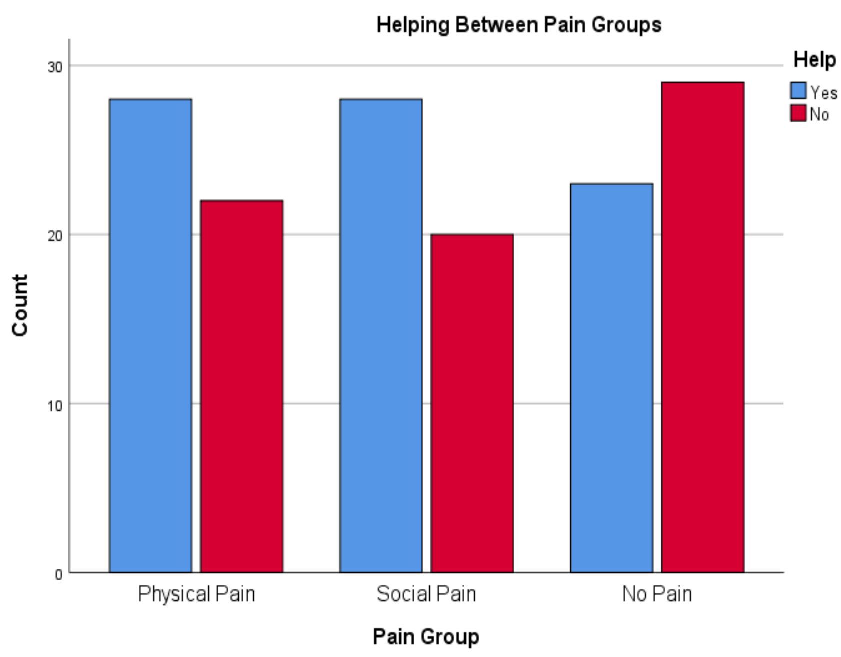

Figure 3. Clustered bar chart displaying the number helpers and non-helpers in each pain

We used a one-way between-groups ANOVA to test whether participants in our pain groups significantly helped pick up more pencils. Participants in the social pain group picked up the most pencils of the three groups, (*N* = 48, *M* = 9.25, *SD* = 10.01), followed by participants in the physical pain group, (*N* = 50, *M* = 8.46, *SD* = 9.59), and the control group (*N* = 52, *M* = 6.10, *SD* = 8.18). The ANOVA did not reveal a significant effect, F(2,149) = 1.59, $p = .21$, $\eta^2 = 0.021$ (Figure 4).

A Levene's test for equality of variance indicated that the assumption of

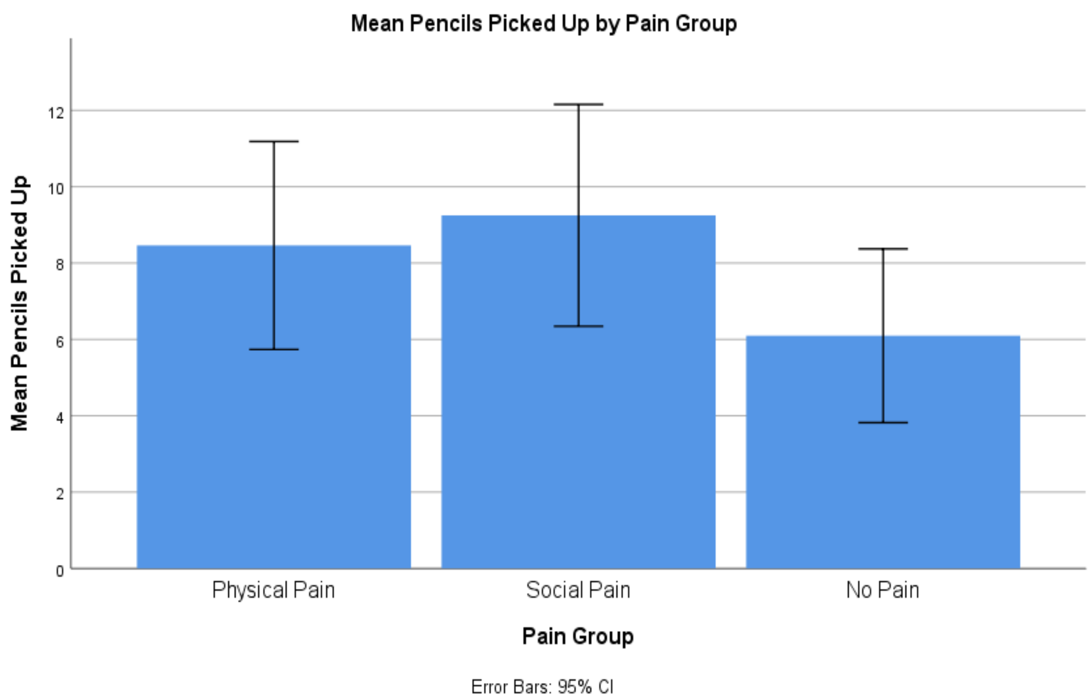

Figure 4. *Bar graph showing mean pencils picked up by pain group. Error bars indicate 95% confidence intervals.*

homogeneity of variance was not met for the number of pencils picked up, F (2,147) = 3.94, $p = .022$. Thus, the results of the preceding ANOVA should be viewed with suspicion. Because of the lack of homogeneity, a nonparametric Kruskal-Wallace test was used to test for differences in the number of pencils retrieved between groups. It also indicated no significant differences, $H(2) = 3.10$, $p = .212$. Given an alpha of .05 and a very small effect size of .15 from our ANOVA, post-hoc test of power analysis using G*Power (Faul et al., 2007) suggests that this study needed a sample size of at least three groups of 151 participants in order to achieve the desired statistical power of .80.

Exploratory Analyses

A one-way ANOVA revealed no significant differences between men and women in pain tolerance, $F(1,48) = .16$, $p = .69$, $\eta^2 = .003$, or pain rating, $F(1,48) = .17$, $p = .68$, $\eta^2 = .003$) among participants in the physical pain condition. There were also no significant differences between men's and women's pain ratings in the social pain condition, $F(1,46) = .53$, $p = .47$, $\eta^2 = .011$ or the no pain condition, $F(1,50) = 2.18$, $p = .15$, $\eta^2 = .041$.

Discussion

We tested how different kinds of pain impacted helping behavior. We hypothesized that we would replicate and extend Olivola and Shafir's (2013) work on the martyrdom effect by showing that experienced (rather than anticipated) physical pain increased helping behavior. Although the means were in the predicted direction, this hypothesis was not supported by significant between-group differences. We also proposed a new hypothesis, that social pain would induce similar behavioral consequences to physical pain and would likewise elicit a higher rate of helping behavior than the no-pain control group. Again, the difference was in this hypothesized direction, but not statistically significant. Debriefing data indicated that both the Cold Pressor Test and Cyberball caused significantly more pain than the no-pain control group, meaning that the manipulations were effective at inducing pain. Cyberball, however, did not induce pain as strongly as the Cold Pressor Test. Based on these results, we are unable to definitively support or reject social pain overlap theory. Although the predicted pattern was found, the lack of significance indicates that it could have been due to chance. We successfully manipulated pain into three distinct levels and were, therefore, able to compare helping behavior between three distinct groups.

Our dependent variable was measured in two ways: if participants picked up any pencils at all and how many pencils they picked up. The majority of participants in the physical and social pain groups helped by picking up at least one pencil while a minority of participants in the control group helped pick up any pencils. Participants in the social pain group, on average, picked up the most pencils but not significantly more than either of the other groups. Thus, there was variability in the dependent variable, as required for statistical analysis: some participants picked up no pencils, and others picked up variable numbers. We can also not attribute the null results to participant skepticism. Debriefing interviews confirmed that the manipulation was subtle enough that no participants guessed that our clumsiness was intentional. While our sample was slightly skewed toward male participants, we cannot attribute our results to sampling. Sex differences in pain sensitivity have been demonstrated previously, but our participants were randomly assigned to conditions, and there were no significant differences between sexes in any condition. Unlike Mitchell, MacDonald, & Brodie (2004), we did not observe gender differences in pain tolerance for the Cold Pressor Test. However, like Mitchell et al. (2004), we found no significant difference between gender and pain rating: both men and women felt similar degrees of pain.

Social Pain Overlap theory posits that physical and social pain share similar neural substrates in the brain, and cause similar behaviors (Eisenberger & Lieberman, 2004). The trends seen in our data are consistent with those predicted by SPOT: participants in both pain groups helped more often and picked up more pencils than participants in the control group. However, without significant differences between groups' helping behavior, we can not lend conclusive support to the theory. Our findings, while not significant, did show increased helping behavior, possibly indicating similar behavioral reactions to physical and social pain.

Leeuwen and his colleagues (2014) theorized that anticipating physical pain increases the likelihood of prosocial behavior. Whereas Leeuwen et al. tested the effects of *anticipated* physical pain, the present study tested prosocial behavior *immediately following* a painful experience. Our results suggest that the difference between anticipated and experienced pain may not be inconsequential. Anticipated pain could be seen as more consistent with reciprocal altruism theory than recently experienced pain because knowing about upcoming pain primes individuals to help now (while at full strength), in order to motivate reciprocation when in pain (and possibly incapacitated) later. We may not have found significant results because our participants had already experienced pain before the opportunity to pick up pencils arose. This may have caused participants to use an avoidant defensive strategy (possibly to conserve energy for a possible recovery) rather than accumulate favors from a skeptical audience for later use as protection. While our results do not provide further support for the martyrdom effect, they do identify a potentially important constraint on it. We remain open to the possibility that it remains valid for anticipated pain, but suggest that it might not extend to experienced pain. Nevertheless, we must acknowledge that those who were in both pain conditions helped more frequently and picked up more pencils than participants in the no-pain control group, so it is possible that experienced pain simply results in a smaller effect. More research is needed to clarify the temporal boundaries of the martyrdom effect.

Implications for SPOT and the Martyrdom Effect

Our results do not conclusively support either of the two foundational theories that inspired our research, leading us to question why our hypotheses were not borne out. We have insufficient reason to believe that either theory is rendered invalid. SPOT theorists have shown that both physical and social pain have overlapping neural responses and some behavioral overlaps. As Amadio (2010) suggests, it is possible that physical and social pain nevertheless maintain some different behavioral consequences, perhaps including helping. Our research does not negate SPOT, but raises some questions about the extent to which physical and social pain produce parallel behaviors, and how much pain is needed to influence behavior. One or both of our manipulations may simply have been too weak.

Our research adds no new evidence to support SPOT theory, but may still contribute by adding attention to SPOT research in particular, and more generally to research that melds social, behavioral, and neurological psychology. Additionally, our results did not extend the martyrdom effect as predicted; current pain did not increase participant's helping behavior in the same way as anticipated pain. The effect originally only applied to anticipated pain, increasing participants' anxiety of pain-to-be. Without the anticipated anxiety of future pain, it is possible participants were not *as* motivated to display helping behavior in our experiment as the original work (Leeuwen et al., 2014). If our results are valid, anticipated pain and experienced pain may not have the same effects on behavior. This would be an important elaboration on the martyrdom effect, and should be a target of future research.

Limitations and Future Directions

Future researchers should continue to improve the methodology for testing the overlapping consequences of physical and social pain. While our study effectively manipulated pain into three differing varieties, the physical pain group's manipulation was significantly stronger than the social pain group manipulation (see Figure 2). In the future, researchers should aim to make the strength of these pain manipulations more directly comparable. One way to do this would be to increase the intensity of social pain. While it has an admirable history, Cyberball is now dated and should either be replaced or updated with a more convincing video game. We estimate that around half of the participants in the social pain group sensed that Cyberball was fake, expressing agreement as they were told that they were not playing with real, remote participants. They revealed their lack of persuasion during post-test debriefing. However, note that one of Williams et al.'s, (2000) conclusions is that the game is an effective manipulation of social pain whether or not the participants knew it was a fake online game. If so, our participants' skepticism may not be important; nevertheless, a more convincing simulation, if available, would not hurt.

Alternatively, the physical pain manipulation could be made less intense. This could be done by implementing a shorter maximum immersion time and/or maintaining a water temperature of 36-37 degrees rather than our 32-33 degree water. The CPT remains an effective manipulation of physical pain, but has room for adjustment. Our dependent variable, picking up "seemingly accidentally" fallen pencils, was largely successful: no participants saw through the ruse. While this activity was successful, we think the timing could be improved to better isolate helping as a construct.

Our participants were placed into a situation where they could either begin the questionnaire or pick up the recently fallen pencils, both behaviors that would help the researcher. After debriefing, some participants said that they considered it more helpful to begin the questionnaire rather than pick up the fallen pencils. Eliminating that choice might better isolate helping behavior into the dependent measure. Finally, we must also acknowledge that our sample was not especially diverse and therefore the results may not generalize to different groups. We did not analyze any ethnic, racial, or socioeconomic variables because of inadequate sample sizes, with 60% of the local student population being white, less than 8% of students from any other race/ethnicity (National Center For Educational Statistics), and coming from a college with an average student family-income of $156,200, more than double the national average (The Upshot, 2020). Future research should attempt to include more diverse samples, and include subject variables as a possible factor, especially pertaining to the possible effect of social pain.

As with any complex behavior, we expect that helping is affected by numerous personality and situational variables. As an initial investigation, we could not include all possible factors. In the future, we recommend including a short questionnaire gauging personality and social variables such as competitiveness, history of social exclusion, perceived pain tolerance, and current mental state prior to participation. Participants who report high pain tolerance may, for example, feel less pain and may not feel inclined to help as much as participants with lower pain tolerance.

Future research should consider simpler behaviors that require less experimenter intervention. Helping behavior is complex and difficult to measure. While our procedure was somewhat realistic, as a helping opportunity that people might experience in real life, each performance by an experimenter was unavoidably different. It could be better to start with a simpler behavior that is easier to standardize and observe without experimenter confounds. Following Schreiber and Mano (2020), researchers could compare how long participants stay occupied with a simple task testing mental toughness, such as a maze task. Based on the martyrdom effect, we would expect participants in pain to work longer than participants experiencing no pain because they may be more compliant with a researcher's request and work longer toward finishing the task.

Much like the martyrdom is congruent with evolutionary thinking (as a consequence of reciprocal altruism), evolutionary theory could inspire some new predictions. For example, the effects of swearing out loud while in pain also reflect the advantage of expressing pain. Stephens & Umland (2011) found that swearing decreases pain ratings during the Cold Pressor Test. This suggests that swearing while in pain may be worth the cost of expressing vulnerability if aid comes and pain decreases. Social Pain Overlap Theory predicts that social and physical pain share similar neural pathways. Thus, if swearing reduces physical pain, it may also reduce social pain.

Leeuwen et al. (2014), the original martyrdom effect theorists, used a questionnaire to measure helping behavior, and therefore they did not have to control for procedural variables that could have confounded their results. Researchers have manipulated the magnitude of a hypothetical donation, or the timeliness of hypothetical aid. DeWall and his team (2008) employed skillful use of a questionnaire by using a likelihood-to-help scale across several scenarios and calculating an average helping behavior. Adding several scenarios increases the reliability of a helping behavior scale. Without the need for experimenter intervention, questionnaire measures helped lessen confounds and produced more easily identifiable trends in the data. Still, no questionnaire can *actually* measure a given behavior. Though we introduced a couple of methodological confounds, we were able to directly measure helping behavior by seeing the behavior for ourselves without self-report errors.

The strength of a questionnaire is that behaviors are more likely to be performed if there is a hypothetical situation with a sliding scale for the participant to imagine their level of helping behavior. Putting participants into a live-action situation to help while the researcher slowly picks up pencils places the participant in a potentially awkward situation. As Milgram (1963) suggests, participants will be in either an autonomous state or an agent state, subject to the experimenter's will. In other words, participants may act because it is their decision, or because the situation demands it, with the experimenter's behavior relieving them of the choice to help altogether. A genuine interaction allows each participant's spontaneous nature to come through.

Our trend indicates that there may be a correlation between recently experienced pain and helping behavior, and that there may be an overlap between behavioral consequences of physical and social pain. Our research illuminates a visible behavior in response to a specific stimulus: pain. The pain of a broken heart, like the pain of a broken bone, has behavioral side effects that could draw us closer to people we love, so in turn our love may be reciprocated. In unfortunate circumstances, people may be drawn to help the very people who cause them pain. This research not only seeks to blend different schools of psychology or explore the relationship between reactions to physical and social pain, but also to have some practical benefit for those whose behaviors feel unproductive or counterintuitive to their wellbeing.

Finally, we return to positive punishment and negative reinforcement, which both work to help lessen future pain. It is possible that humans respond to anticipated pain and experienced pain similarly. Additionally, pain may play similar roles in social settings, occupying similar neural pathways and leading to consequences similar to those following physical injury. Reciprocal altruism could provide the lens through which researchers view all prosocial behavior, and the theory can be of particular relevance when altruism seems counterintuitive. While the conclusions remain open, we hope that this project establishes possibilities for future research.

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