

Can Chicken Noodle Soup Soothe the Rejected Soul?

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Dedication

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Abstract

The idea that consuming a specific, personally meaningful food, also known as a comfort food, can improve an individual's mood is ubiquitous in our culture, but recent research findings have been mixed. The purpose of these studies was to determine the effectiveness of comfort food for preventing or diminishing distress caused by social pain, and, because social pain and physical pain are thought to involve the same neural pathways, to also determine the effectiveness of comfort food for preventing physical pain. In Study 1, participants were socially excluded during an online game, and during the study, they received a comfort food to consume or a comfort food as a gift, either before or after the social exclusion task, or they received nothing at all. Participants who consumed a comfort food after being socially rejected were less distressed compared to those in the other conditions. In Study 2, participants were given a comfort food to consume, a comfort food as a gift, or nothing at all and then completed a pressure-pain task. In contrast to the results from the first study, comfort food consumption did not reduce distress or pain perception in Study 2. The results of these studies suggest that comfort food might not reduce an overall negative affect (Wagner et al., 2014), but that it appears to reduce distress caused by social pain. The effectiveness of comfort food was due to actually consuming it, as merely receiving it as a gift to consume later did not reduce distress. Additionally, comfort food was not effective at preventing either social or physical pain.

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Can Chicken Noodle Soup Soothe the Rejected Soul?

“Stressed is just desserts spelled backwards.” As this popular quote suggests, people associate certain foods, often high-calorie foods, with relief from distress. Although people assume these foods have the ability to comfort those who are experiencing distress, research-to-date is inconclusive. Recent research suggests that comfort food might not alleviate general negative affect (Wagner, Ahlstrom, Vickers, Redden, & Mann, 2014), but that it might diminish the distress associated with social pain (Troisi & Gabriel, 2011; Troisi, Gabriel, Derrick, & Geisler, 2015). Individuals’ experience of social pain, or feelings of distress from actual or perceived social rejection, appears to be processed through the same neural pathways that are activated when individuals endure physical pain (Eisenberger, 2012). Because of this overlap between the social-pain system and the physical-pain system, factors that affect one type of pain also can affect the other. In particular, both types of pain can be reduced through the same process—perhaps even by comfort food. The purpose of this study was to investigate the effectiveness of comfort food for preventing or diminishing individuals’ social and physical pain.

The Role of Comfort Food

Comfort food can be defined as those foods that elicit a psychological sense of well-being and that are often associated with a sense of being with family or close others (Wansink, Cheney, & Chan, 2003). This concept that specific foods have the ability to improve an individuals’ emotional state appears to be ubiquitous in American culture.

For example, a recent Amazon search for “comfort food cookbook” yielded over 1,000 results. This cultural assumption that specific foods do lead to mood improvement has most likely guided much of the previous comfort food research. The majority of the research has focused on which foods individuals consider to be their comfort foods and whether consumption of comfort food increases during specific time periods. Based on survey results, individuals do hold the belief that specific foods can be comforting, but the particular foods that individuals find comforting varies by gender and age. Men and older individuals, ages 35 and over, prefer warm, hearty, meal-related comfort food, such as pasta, pizza, steak, burgers, and casseroles, whereas women and younger individuals, ages 18-34, prefer snack-related comfort food, such as candy, chocolate, and potato chips (Wansink et al., 2003). To determine when comfort food is most likely to be consumed, researchers have relied on both lab-based studies and observational designs and have found that comfort food consumption increases when individuals are stressed. For example, high-school students (Michaud, Kahn, Burlet, Nicolas, & MeJean, 1990), college students (Oliver & Wardle, 1999), and university faculty (Kandiah, Yake, & Willet, 2008) report increased snacking, specifically on foods typically described as comfort foods, during the more stressful periods of a semester. Additionally, participants who were stressed during a lab-based task ate more M&Ms compared to participants who were not stressed (Zellner, Loaiza, Gonzalez, Pita, Morales, Pecora, & Wolf, 2006). This literature has for the most part ignored whether or not people actually experience mood improvement after consuming their comfort food.

Only a few studies have assessed whether consuming comfort food improves people's mood, and the results have been inconsistent. In two studies, Macht and Mueller (2007) investigated the effects of comfort food on mood. In the first study, participants watched sad film clips for three minutes and rated their mood immediately before and after consuming either chocolate or water. Chocolate significantly repaired mood compared to water. In the second study, participants ate palatable chocolate, unpalatable chocolate, or nothing after viewing a sad film clip. At one minute post-consumption, palatable chocolate significantly improved mood compared to unpalatable chocolate or nothing. At two minutes post-consumption, palatable chocolate, compared to consuming nothing, significantly improved mood, and after three minutes, there were no significant differences among the three conditions. These studies, however, assessed only the effects of consuming palatable food, in general, and not specifically comfort food, as the comparison conditions were unpalatable foods or water.

Wagner et al. (2014) also investigated the effects of comfort food on mood, but they improved upon the design by Macht and Muller (2007) by using palatable foods as one of the comparison groups. In Studies 1-3, participants ate their comfort food during one session and consumed an equally liked non-comfort food (Study 1), a neutral food (e.g., granola bar; Study 2), or nothing (Study 3) in a separate session. In each session, participants viewed an 18-minute video clip compilation, which induced overall negative affect (i.e., fear, anxiety, sadness, and anger), and then consumed their snack. In contrast Macht and Muller's (2007) findings, Wagner et al. (2014) found that comfort food was

no more effective at improving mood than was an equally liked non-comfort food, a neutral food, or nothing.

In a fourth study, Wagner et al. (2014) included a pre-film consumption condition to determine whether comfort food (i.e., chocolate) might prevent distress, and they included a pre-film gift condition to separate any beneficial effects of merely receiving a gift of food from the effects of consuming food. Similar to the first three studies, consuming comfort food was no more effective at improving mood than was eating nothing. However, participants who received comfort food to eat or as a gift before the film were significantly less distressed by the film than were the participants who received nothing before the film. These mood differences were no longer significant by the end of the study. Wagner et al. (2014) focused on general negative affect; perhaps comfort foods are only effective at mood improvement for specific types of distress.

Troisi and colleagues (Troisi & Gabriel, 2011; Troisi et al., 2015) have investigated a possible connection between food and a specific type of stress, social distress. In an initial study, participants who ate a comfort food (i.e., chicken noodle soup) later used more relationship-related words than neutral words to complete a word-fragment task, showing greater accessibility of relationship-related thoughts, which suggests that participants automatically associated comfort food with close others (Troisi & Gabriel, 2011).

In a follow-up study, securely attached participants who felt that their relationship with a close other was threatened were less likely to feel lonely after thinking about their

own comfort food (although this was not true for insecurely attached participants; Troisi & Gabriel, 2011). Therefore, simply thinking about their comfort food helped protect securely-attached participants from feelings of social pain. In a separate study, Troisi et al., (2015) manipulated participants' sense of belongingness and assessed feelings toward a specific food, potato chips, which was consumed after the belongingness-threat manipulation. After participants experienced a threat to their belongingness need, securely-attached participants rated potato chips significantly more positively, but the researchers did not assess whether these positive rankings translated into an improved mood. Finally, using a daily-diary design, Troisi et al., (2015) found that securely attached participants were more likely to eat comfort food on days after they experienced greater than usual social isolation. Taken together, these results show that individuals associate comfort food with social relationships, and that consumption of comfort food increases after individuals feel more lonely than usual. Although Troisi and colleagues found an association between comfort food and social relationships, they failed to assess the effect on individuals' emotional well-being of consuming comfort food after experiencing some type of social rejection.

Macht and Mueller (2007) and Troisi and colleagues (Troisi & Gabriel, 2011; Troisi et al., 2015) found that comfort food improved mood and decreased social distress, respectively. Wagner et al. (2014) found comfort food to be ineffective for improving mood. However, Wagner and colleagues did find that both consuming and receiving a comfort food prior to experiencing a negative-mood induction prevented distress. This

finding suggests that comfort food might provide the greatest mood-boosting benefit before rather than after a negative experience, but more research is needed. Overall, the studies assessing comfort food's ability to prevent or decrease distress are inconclusive.

One explanation for the conflicting findings is that comfort food might be effective at reducing *specific forms* of distress instead of overall, diffuse negative mood. Wagner and colleagues found comfort food to be ineffective for a general negative mood induced by watching others (i.e., fictional characters) be sad, frightened, or endure anxiety. However, comfort food might be beneficial for more specific forms of negative distress. The definition of comfort food suggests that these types of foods are linked to our social relationships, and individuals have been found to automatically associate comfort foods with close others (Troisi & Gabriel, 2011). Therefore, comfort food might help to reduce individuals' feelings of social pain, and because the social-pain and physical-pain systems overlap, comfort food might actually decrease the distress associated with both forms of pain.

Social Pain

Individuals display an inherent motivation to form and maintain social relationships (Baumeister & Leary, 1995). According to the belongingness hypothesis, individuals, driven by their motivation to belong, strive to maintain relationships that allow for positive interactions and mutual concern for well-being (Baumeister & Leary, 1995). When individuals' attempts at social inclusion fall short, they feel socially rejected, which decreases their overall well-being (DeWall & Bushman, 2011).

Individuals feel socially rejected when excluded by their close friends and even when excluded by strangers. Social rejection leads to feelings of social pain, defined as “the distressing experience arising from the perception of actual or potential psychological distance from close others or a social group” (Eisenberger & Lieberman, 2004, p. 294).

People often describe the distressing experience of social pain in ways that mirror physical pain, such as “a broken heart,” “gut-wrenching loneliness,” or “heartache,” and this linguistic similarity is thought to be more than a coincidence. Relationship researchers have hypothesized that the evolutionarily newer social-attachment system co-opted the older physical-pain system, which detects and prevents physical damage (Eisenberger & Lieberman, 2004). This co-opting would have been evolutionarily adaptive for the social attachment system in order to help humans to detect and prevent social separation, thereby preventing social pain. Researchers have supported this hypothesis by using neuroimaging techniques that show evidence of common neural bases between the two systems (Eisenberger, 2012; 2012b) and by demonstrating that individuals’ social or physical pain can be worsened or reduced by similar processes (Eisenberger, Jarcho, Lieberman, & Naliboof, 2006), suggesting that comfort food might be one way to reduce both types of pain.

Evidence of a Shared System

Individuals’ overall well-being diminishes with social exclusion, and this would have been especially true for our ancestors who depended on the social group for survival. By co-opting the physical-pain system, the social-attachment system developed

an adaptive solution for maintaining social relationships (Eisenberger & Lieberman, 2004). Both systems are geared for detecting physical dangers, social separation, or cues of other situations that threaten survival. After detecting these threatening cues, both systems then focus attention on avoiding or overcoming the perceived threat. Pain, physical or social, signals individuals to alter their behavior in order to decrease their pain and regain their well-being (Eisenberger & Lieberman, 2004). The newer social-attachment system relies on the primitive physical-pain system's framework to help ensure the maintenance of crucial social relationships.

Researchers have found evidence of common neural bases, specifically the dorsal anterior cingulate cortex (dACC), between the two systems. The dACC processes physical-pain affect, which is the emotional aspect of pain (MacDonald & Leary, 2005). For example, chronic pain patients with lesions in their dACC are able to accurately report where their pain is located but are no longer bothered by it (Eisenberger, 2012b). The dACC also processes social pain. For example, patients with a portion of their dACC removed are no longer concerned about how others view them and show an overall decrease in concern for maintaining social relationships (Eisenberger, 2012).

Researchers implementing neuroimaging techniques using functional magnetic resonance imaging (fMRI) scans have found evidence of dACC activation in response to both physical pain and social pain. For example, individuals manifest increased dACC activity while thinking about a recent "ex" and their rejection experience (a social pain manipulation) and while enduring heat pain (a physical-pain manipulation; Kross,

Berman, Mischel, Smith, & Wager, 2011). Additionally, participants have shown increased dACC activation when experiencing social evaluative threat (Eisenberger, Inagaki, Muscatell, Haltom, & Leary, 2011; Wagner et al., 2009), reliving rejection from close others (Fisher, Brown, Aron, Strong, & Mashek 2010), or being socially excluded by a group (Eisenberger, Lieberman, & Williams, 2003). Eisenberger and colleagues also found that participants' self-reported distress was positively correlated with dACC activation (Eisenberger et al., 2003).

In addition to common neural bases, the social-attachment system and the physical-pain system have a common neurochemical substrate, endogenous opioids. Endogenous opioids are responsible for regulating physical pain, and higher levels of endogenous opioids decrease pain levels (MacDonald & Leary, 2005). When animals experience a decrease in their opioid levels, their physical pain levels increase, and they behave as if they are oblivious to social cues leading to distress. Additionally, when animals are administered exogenous opioids (i.e., morphine), they show less social distress (MacDonald & Leary, 2005).

Because the social-attachment system and the physical-pain system share common features (i.e., neurochemical substrates and neural bases), they are affected similarly by factors that are traditionally thought to increase social or physical pain. For example, social exclusion similarly affects the social-attachment system and physical-pain system. Compared to participants who were included during an online ball-toss

game, those who were excluded reported increased social distress and greater unpleasantness to a heat pain stimulus (Eisenberger, et al., 2006).

Additionally, inflammation, a common response to physical injury, also affects social interaction. Participants injected with endotoxin, an agent that increases inflammation, showed the typical increase in inflammatory response, and they also showed an increase in feelings of social disconnection (Eisenberger, Inagaki, Mashal, & Irwin, 2010). These results suggest that social exclusion and inflammation increase both social and physical pain and provide further evidence of an overlap between the social-attachment system and the physical-pain system.

Finally, individual differences also appear to affect the social-attachment system and physical-pain system. Specifically, researchers in this area of study have investigated the differences in individuals' pain sensitivity. Sensitivity to physical pain appears also to affect social pain. Participants with greater baseline sensitivity to pain, as measured by having a lower pain threshold, later reported greater social distress after being excluded during an online ball-toss game (Eisenberger et al., 2006).

Negative Health Consequences of Experiencing Social or Physical Pain

Distress, whether caused by physical or social pain, automatically activates the physiological stress response. The physiological stress response can be beneficial for short-lived stressors, such as providing the necessary strength to run from a mugger, but this response can result in negative-health outcomes (Dickerson & Kemeny, 2004). For example, participants engaging in a social-evaluative-stressor task have shown increased

inflammation activity (Dickerson, Gable, Irwin, Aziz, Kemeny, 2009), and increased inflammation is associated with many chronic diseases of aging (Eisenberger, 2012b). Additionally, constant activation of the physiological stress response speeds up the aging process (Epel et al., 2004). Another example comes from research on immune system functioning. Individuals who report increased stress after being socially excluded show decrements in their immune system (Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997).

Overall, individuals with lower amounts of objective or subjective social support have a greater risk of mortality (Eisenberger, 2012b), and this risk represents “a comparable health risk factor to smoking, obesity, or high blood pressure” (Alvares, Hickie, & Guastella, 2010, p. 316). Additionally, socially excluded individuals have higher rates of depression, increased anxiety, and lower self-esteem (Bernstein & Claypool, 2012; Eisenberger, 2012b). In contrast to social exclusion, social support is associated with overall physical benefits, which may be a result of a slowed aging process (Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Physical stress and social stress have detrimental effects on individuals’ health, creating a need to identify more ways to decrease or eliminate individuals’ experience of social pain.

Methods of Reducing Social and Physical Pain

Researchers have identified several different methods for reducing social and physical pain. For example, social support is beneficial for both pain systems (Eisenberger, 2012b). During exposure to a painful heat stimulus, participants saw an image of their partner, an image of a stranger, or an image of a ball, and they held their

partner's hand, held a stranger's hand, or held a ball. Participants who felt socially supported either by seeing an image of their partner or by holding their partner's hand reported feeling significantly less physical pain compared to participants in the other conditions (Master et al., 2009). In a neuroimaging study, participants who were able to see their partner's image while undergoing a pain manipulation showed less dACC activity (Eisenberger et al., 2011b).

Researchers have also studied pain-relieving medications as a method for reducing physical and social pain. DeWall and colleagues conducted two studies in which participants took acetaminophen, a non-aspirin pain reliever, for three weeks. At the end of the three weeks, participants in Study 1 provided self-reported social pain ratings, and after three weeks, participants in Study 2 had an fMRI scan. Compared to participants taking a placebo, participants who took acetaminophen for three weeks reported decreased hurt feelings and showed less dACC activity (DeWall et al., 2010). Social support and pain-relieving medications are factors that have similar beneficial effects on the social-attachment system and the physical-pain system.

Manipulating the dopamine reward system may provide another method for decreasing social and physical pain. For example, participants primed with the concept of money showed a decrease in negative affect after being socially excluded (Zhou & Gao, 2008). Eisenberger (2008) proposed that the money prime reduced participants' social distress by working through the dopamine reward system. Increased levels of dopamine have been associated with pain suppression (Eisenberger, 2008). If money reduces social

distress, then perhaps other factors contingent on increasing dopamine-related processes may diminish social and physical pain. Small, Jones-Gotman, and Dagher (2003) measured participants' dopamine levels, using a positron emission tomography (PET) scan, after participants completed a 16-hour fast and ate their favorite meal. Participants showed a dopamine release immediately after consuming a favorite meal. These results suggest that although comfort food might not reduce an overall negative mood, it might be one factor that can diminish social and physical pain.

Study Overview

Researchers investigating comfort food, commonly assumed to alleviate emotional distress, have focused mainly on the types of foods people choose when they need to be comforted. However, recent research has started to investigate the effects of consuming comfort food, but with mixed results. These studies suggest that comfort food might not alleviate a general negative affect (Wagner et al., 2014) but that it might help to reduce a specific type of distress, such as social pain (Troisi et al., 2015). If the social-attachment system and the physical-pain system are connected, then a method, such as consuming comfort food, which successfully decreases social pain, should also decrease physical pain. The primary purpose of these studies was to investigate the effectiveness of comfort food for preventing or diminishing pain levels and negative affect when individuals are socially excluded or when individuals experience physical pain. Additionally, these current studies extended previous work by controlling for the effects of merely receiving (but not eating) a comfort food by including a pre-pain gift-of-food

condition and a post-pain gift-of-food condition—both control conditions—to ensure that participants were comforted by consuming the food rather than by simply receiving the unexpected gift of food.

Study 1

Study Design

Study 1 used a repeated-measures, between-subjects design. In this study, participants first completed an online survey. Before participants arrived to the lab, they were randomly assigned to one of five conditions: (1) receive pre-pain comfort food to consume, (2) receive pre-pain gift of food (no consumption), (3) receive post-pain comfort food to consume, (4) receive post-pain gift of food (no consumption), or (5) receive nothing during the study. [See Table 1 for a listing of these conditions.] During the 30-minute lab session, all participants completed the social-pain induction, and they completed surveys assessing distress and emotional pain four times: at the beginning of the study, before the social-pain induction, after the social-pain induction, and at the end of the study. [See Figure 1 for a description of the timeline and Appendix A for a step-by-step overview of the methods.] All of the methods were approved by the IRB committee at the University of Minnesota, and the study design was pre-registered with the Open Science Framework.

Main Research Questions and Predictions:

Listed below are the primary research questions and hypotheses. [See Table 3 for an overview of all main hypotheses.]

1) *Will eating a comfort food before the social-pain task (Condition 1) prevent reported distress and emotional pain directly after the task (Time 3) compared to eating or receiving nothing before the task (Conditions 3, 4, & 5)?* Wagner, et al., (2014) found that participants who consumed chocolate, a common comfort food (Oliver & Wardle, 1999), before watching negative-mood-inducing film clips were significantly less distressed directly after the film compared to participants who did not consume chocolate before viewing the clips. Therefore, participants who consume a comfort food before completing a social-pain task might be protected from the distress associated with social pain. Eisenberger (2008) hypothesized that dopamine-releasing processes, such as consuming comfort food, might decrease social pain because increased dopamine can reduce physical pain. Additionally, Small and colleagues (2003) documented immediate dopamine release after participants ate their favorite meal, which suggests that the process of consuming comfort food and not the slower process of nutrient absorption is responsible for dopamine release. Therefore, participants who consume a comfort food before the social pain task might have an increase in dopamine and report less pain after the task.

Hypothesis 1: Participants who consume a comfort food before the social-pain task (Condition 1) will report less distress and emotional pain directly after the task (Time 3) compared to participants who eat nothing and to those who receive nothing before the task (Conditions 3, 4, & 5).

- 2) *Will receiving a comfort food before the social-pain task (Condition 2) prevent reported distress and emotional pain directly after the task (Time 3) compared to eating or receiving nothing before the task (Conditions 3, 4, & 5)?*

Wagner et al. (2014) found that participants who received a comfort food as a gift before viewing 18-minutes of negative film clips were in a better mood after the film compared to participants who received nothing before the film clips.

Therefore, receiving a comfort food should prevent participants' mood from becoming as negative as the mood of participants who receive nothing and eat nothing before the film clips. Wagner et al. (2014) did not assess why a gift before the film might have been protective, but perhaps receiving a gift of food distracts individuals from the upcoming distressing task (McCaul & Malott, 1984). Although receiving a gift of food might not be as protective as actually consuming a comfort food (see Hypothesis 4), participants who receive a comfort food might have less pain, perhaps through distraction, compared to participants who do not eat or receive anything before the social pain task.

Hypothesis 2: Participants who receive a comfort food before the social-pain task (Condition 2) will report less emotional pain and distress directly after the task (Time 3) compared to participants who eat nothing and compared to those who receive nothing before the task (Conditions 3, 4, & 5).

- 3) *Will eating a comfort food after the social-pain task (Condition 3) lead to less distress and emotional pain by the end of the study (Time 4) compared to eating*

nothing and receiving nothing during the study (Condition 5)? Currently, research findings are inconclusive concerning the beneficial effects of comfort food for reducing distress. Wagner et al. (2014) found comfort food, largely assumed to increase positive affect, to be ineffective for significantly decreasing negative affect; however, they used film clips to induce an overall negative mood. Macht and Mueller (2007), who also used film clips to manipulate mood, did find comfort food to be effective for reducing participants' sadness. Troisi and Gabriel (2011) used a more socially relevant manipulation—belongingness threat—and found that participants who felt that their need to belong was threatened subsequently felt less lonely after thinking about their comfort food. Overall, these results suggest that comfort food might not protect individuals against a general negative mood, which is more diffuse, but that comfort food might reduce individuals' distress specifically associated with social pain, which is a more acute form of distress. As mentioned above, comfort food might decrease social pain through an immediate release of dopamine (Small et al., 2003). Therefore, participants who consume a comfort food after the social-pain task, like participants who consume a comfort food before the social-pain task, might experience an increase in dopamine and report less pain at the end of the study.

Hypothesis 3: Participants who consume a comfort food after the social-pain task (Condition 3) will report less distress and emotional pain by the end of the study

(Time 4) compared to participants who eat nothing during the study (Condition 5).

- 4) *Will eating a comfort food before the social-pain task (Condition 1) prevent reported distress and emotional pain directly after the task (Time 3) compared to receiving a gift before the task (Condition 2)?* Wagner et al. (2014) found that participants who either consumed a comfort food or who received a comfort food as a gift before a negative mood induction—viewing negative film clips—were in better moods after the film compared to participants who received nothing before the film clips. Additionally, participants in the pre-consumption and pre-gift conditions were not significantly different from each other. These results suggest that participants who receive a comfort food or who receive a comfort-food gift might show similar levels of distress. However, individuals who consume a comfort food might experience different levels of emotional pain compared to individuals who receive a gift of comfort food. Berridge (2007) concluded that dopamine is related to “wanting” and that dopamine is released in response to *obtaining* something wanted. Only participants who are able to eat the comfort food will show an increase in dopamine levels because those in the gift condition will still be in the “wanting” phase. Therefore, participants who consume comfort food before the social-pain task might report less emotional pain compared to participants who receive a comfort food gift before the task.

Hypothesis 4: Participants who consume a comfort food before the social-pain task (Condition 1) will report similar amounts of distress but less emotional pain immediately after the task (Time 3) compared to those who receive a gift before the task (Condition 2).

- 5) *Will eating a comfort food after the social-pain task (Condition 3) lead to less distress and emotional pain by the end of the study (Time 4) compared to receiving a gift after the task (Condition 4)?* As discussed above, findings are mixed regarding the effect of comfort food on reductions in distress after negative-mood manipulations, but the overall pattern of results suggests that comfort food may reduce distress specifically associated with social pain (Macht & Mueller, 2007; Troisi & Gabriel, 2011; Troisi et al., 2015; Wagner et al., 2014). None of the discussed studies included a post-pain comfort food gift, which prevents a strong prediction. Because the literature suggests that consuming a comfort food and receiving a gift before a distressing task is protective, participants might report similar levels of distress after either consuming a comfort food or receiving comfort food as a gift, compared to receiving nothing. However, the pattern of results for individuals' emotional-pain experience is expected to differ, based on the same reasoning as discussed for Hypothesis 3: Receiving a comfort-food gift might not lead to the same dopamine-releasing process as consuming a comfort food. Therefore, participants who consume a

comfort food should report less emotional pain than participants who receive a comfort-food gift.

Hypothesis 5: Participants who consume a comfort food after the social-pain task (Condition 3) will report a similar level of distress but less emotional pain at the end of the study (Time 4) compared to those who receive a gift after the task (Condition 4).

- 6) *Will eating a comfort food after the social-pain task (Condition 3) lead to less distress and emotional pain at the end of the study (Time 4) than eating a comfort food before the task (Condition 1)?* Wagner et al., (2014) found that there were no significant differences in mood by the end of a 30-minute study for participants who ate a comfort food either before or after a negative mood induction. Macht and Mueller (2007) and Troisi and colleagues (Troisi & Gabriel, 2011; Troisi et al., 2015) did not have participants eat a comfort food before the mood manipulation. Because of a lack of research findings, it is only possible to speculate regarding the results. If dopamine levels are responsible for decreasing pain, then participants with higher dopamine levels by the end of the study should have less emotional pain. Therefore, participants who consume a comfort food further into the study might have higher levels of dopamine by the end of the study.

Hypothesis 6: Participants who consume comfort food after the social-pain task (Condition 3) will report less distress and emotional pain by the end of the study

(Time 4) compared to participants who consume comfort food before the task (Condition 1).

Exploratory Questions & Predictions:

7) *Will participants who have an overall greater level of social support in their lives, regardless of condition, report less distress and emotional pain by the end of the study (Time 4)?* Researchers have found that social support decreases individuals' social and physical pain (Eisenberger, 2012b). For example, participants who were either able to hold their partner's hand or see a picture of their partner reported less pain after experiencing heat pain (Master et al., 2009). Therefore, social support should moderate the effects of a social pain task, with greater levels of social support related to lower levels of distress and emotional pain in response to the social pain task.

Hypothesis 7, Exploratory: The more social support participants report having in their lives, the less distress and emotional pain they will report by the end of the study (Time 4).

8) *Will social support level interact with the manipulations (Conditions 1 & 3 v. 5) in predicting distress and emotional pain by the end of the study (Time 4)?* Participants who have an overall greater level of social support in their lives might not be as strongly affected by consuming comfort food because they already experience less social pain (Master et al., 2009). Therefore, participants who have lower levels of social support might experience more of a positive-

affect boost from consuming the comfort food and self-report less distress and emotional pain.

Hypothesis 8, Exploratory: Social support will interact with experimental condition such that the lower the level of social support, the less emotional pain participants who consume a food (Conditions 1 & 3) will report by the end of the study (Time 4) compared to participants who do not consume a food (Condition 5).

Participants:

A total of 150 University of Minnesota students (101 women, 48 men, and 1 unreported) participated in this study. Each condition had 30 participants, and based on a prior power analyses, 30 participants per condition would have allowed me to detect an effect of size .64 with a power of 0.80. Participants earned \$10.00 or extra credit in their psychology courses for their time in the study. Individuals were eligible for the study if they indicated that chocolate bars or potato chips were a comfort food. All participants were 18 years old or older, and the participants' average age was 21.4 years old. The majority of the participants were white (66%), followed by Asians (21.3%), and others (12.7%). Three participants were dropped from the study due to methodological errors: One participant refused to eat the chocolate bar in the comfort-food-consumption condition and two others failed to understand the instructions and took the surveys at the wrong times. Therefore, the final number of participants included in the analyses was 147; with 7 men and 21 women in Condition 1, 8 men and 21 women in Condition 2, 8

men and 21 women in Condition 3, 10 men and 20 women in Condition 4, and 13 men and 17 women in Condition 5.

Procedure:

Participants responded to recruitment fliers around campus as well as to postings on the Psychology Department's experiment sign-up website for a study ostensibly investigating "the effects of glucose on everyday tasks." When participants contacted the lab to schedule a session, they were provided with a link to the initial online survey, which indicated that the purpose of the study was to investigate the effects of glucose on day-to-day interactions. During this online survey, participants completed a perceived-social-support measure (Zimet, Dahlem, Zimet, & Farley, 1988), a demographics questionnaire, and a comfort-food preferences survey. If participants indicated chocolate bars or potato chips as a comfort food preference, then a research assistant contacted the participant to schedule a lab session for one week after completion of the online survey. Before arriving at the lab, participants were randomly assigned to one of the five conditions: (1) receive pre-pain comfort food to consume, (2) receive pre-pain gift (no consumption), (3) receive post-pain comfort food to consume, (4) receive post-pain gift (no consumption), or (5) receive nothing during the study. All participants were run in individual sessions.

When participants first arrived at the lab, they once again heard about the purpose of the study. Research assistants explained to the participants:

“We are interested in learning more about how glucose affects social interactions, including learning about how the individual feels before, during, and after these interactions. We are interested in this topic because of the increase in snacking, especially sweet snacks, over the last decade, and an increase in snacking means more people are interacting with others immediately after consuming a glucose-rich snack.”

Next, participants read and signed the consent form. Research assistants answered any questions the participants might have had before continuing on with the study. After all questions had been answered, the research assistant sat participants at a computer and then provided them with an overview of the procedures of the study:

“The majority of the study will take place on this computer. At different times throughout the study, you will need to inform me that you are ready for the next task. The computer will alert you when it is time to come get me. Do NOT continue on with the study until I inform you that it is okay to continue. Do you UNDERSTAND??? I’ll be right outside this door in the next room.

“To begin, you’ll complete a few measures to assess how you are feeling before completing any tasks. Then you will complete the social-interaction task, which will be an online game played with participants who are currently in partnering social psychology labs across the Big Ten. The computer will alert you when you need to come get me so I can get you started on this social interaction task. Again, do NOT move ahead in the survey or with the game until I inform you that it is time to

continue. I will provide more information on this task once it is time to play the game. After the game, you will complete more questionnaires so we can learn how you are feeling after this task. There may be times during the experiment when we will ask you to simply sit quietly before moving on to the next part, and we may provide a glucose-rich snack during the experiment. Do you have any questions regarding the process for this study?"

After research assistants felt that participants understood the procedures, they left the room to allow the participants to begin the first part of the study. Participants completed the Time 1 measures: the Positive and Negative Affect Scales (PANAS; Watson, Clark, & Tellegen, 1988) and the emotional-pain slide (Chen et al., 2008). This measure assessed participants' mood and emotional-pain levels. After completing the questionnaires, the computer displayed a message that prompted the participant to alert the research assistant that he or she had finished with this portion of the study and was ready for the next part. At this time, research assistants provided participants with their comfort food, either a chocolate bar or a small bag of potato chips, and asked them to eat it (Condition 1), gave participants their comfort food as a gift but told them not to eat it until after the study was over and to simply sit quietly (Condition 2), or asked participants to simply sit quietly (Conditions 3, 4, & 5). The research assistants left the participants alone for three minutes to eat their comfort food or to sit quietly. Immediately following the three-minute time block, the research assistants informed participants that it was time

to continue with the surveys on the computer. Participants completed the Time 2 measures: the PANAS and the emotional-pain slide.

Again, the computer displayed a message that prompted the participant to inform the research assistant that he or she was ready for the next part of the study. Research assistants returned to explain Cyberball (Williams, Cheung, & Choi, 2000), the social-pain induction:

“Cyberball is an online, ball-toss game. You’ll be playing this game because it mimics real-life interactions, especially with our increasingly digital world. In particular, we want you to mentally visualize this task. Imagine what the other players look like. What sorts of people are they? Where are you playing? Create in your mind a complete mental picture of what might be going on if you were playing this game in real life.

“During the game you’ll be throwing a ball back and forth with two other students, who are participating in similar studies at partnering labs in other Big Ten schools. The other students will be represented by cartoon figures at the top of the screen, and you’ll be represented by a drawn hand at the bottom of the screen. When you are thrown the ball, you can throw the ball to another student by clicking on that student’s cartoon image. The game will last for a few minutes. Because the game has multiple players all in different locations, it may take anywhere from a few seconds to a few minutes for the game to begin. Do you have any questions?”

Once research assistants fully explained the procedure and answered any questions from the participants, they left the room to provide participants with privacy while they played the game. Immediately after the game ended, participants completed emotional-pain and mood measures (Time 3). Additionally, participants completed the Need Threat Scale (Williams et al., 2000), which is a manipulation check to verify that participants did feel excluded after the social-pain task. After participants completed the surveys, they received a message from the computer prompting them to inform research assistants that they were ready for the next part of the study.

Next, research assistants provided participants with their comfort food to eat (Condition 3), gave comfort food as a gift to participants but told them not to eat it until after the study and to simply sit quietly (Condition 4), or did not give participants any food and asked them to simply sit quietly (Conditions 1, 2, & 5). Research assistants left the room for three minutes while participants ate their comfort food or sat quietly. Following this second three-minute time block, research assistants instructed participants to return to the computer to complete the final measures (Time 4).

Following the final mood and emotional-pain measures (Time 4), participants also explained in their own words what they thought the study was about and whether they were suspicious at any point during the study. Finally, research assistants debriefed the participants to ensure that no participants felt distressed before leaving the lab.

Stimuli

Comfort food: Research assistants provided participants in the comfort food conditions (Conditions 1, 2, 3, & 4) with either a milk chocolate bar or a small bag of potato chips. Milk chocolate and potato chips were chosen as the comfort foods because of the demographics of the participants. The average age of the participants was 21.4 years old, and 67% of participants were women. Women and young adults prefer snack-related comfort foods, such as chocolate and potato chips (Wansink et al., 2003; Oliver & Wardle, 1999), and researchers commonly use these snack-related comfort foods (Macht & Mueller, 2007; Scholey & Owen, 2013; Wagner et al. 2014). Additionally, participants were pre-screened to ensure that either chocolate bars or potato chips was their preference for a comfort food.

Social Exclusion Task: All participants played the online game Cyberball (See Appendix C for a screenshot; Williams & Jarvis, 2006). In Cyberball, participants use a mouse to toss a ball with two other supposed students, who are actually the computer program. Cyberball is an effective method for inducing a sense of social exclusion in participants (Williams et al., 2000). Additionally, Cyberball has been used in 142 published papers, many investigating social pain (e.g., Bernstein & Claypool, 2012; Eisenberger et al., 2006; Riva, Wirth, & Williams, 2011).

During the game, all participants were socially excluded. Participants were included in the ball-toss game for the first minute and then excluded for the following two minutes (procedure adapted from Eisenberger et al., 2006). After the game finished,

participants received a message from the computer to alert research assistants that the game had finished and that they were ready for the next part of the study.

Measures

Dependent Variables:

PANAS: The PANAS (see Appendix D) is a 20-item questionnaire consisting of mood words (e.g., anxious), and participants use 5-point scales (1 = “very slightly/not at all”; 5 = “extremely”) to report the extent to which they currently feel each mood or emotion. The PANAS has been found to be a reliable (Cronbach’s alpha was 0.89 for positive-affect subscale and 0.85 for negative-affect scale) and valid measure of mood (Crawford & Henry, 2004). The PANAS is a commonly used mood measure in social-pain research (Gerber & Wheeler, 2009). The positive-affect scale was scored by adding participants’ scores on the 10 positive words, with scores ranging from 10-to-50 and higher scores indicating greater positive affect. The negative-affect scale was scored by adding participants’ scores on the 10 negative words, with scores ranging from 10-to-50 and higher scores indicating greater negative affect.

Emotional-Pain Slide: The pain slide (see Appendix E) is a commonly used pain measure in the medical area and in social-pain research (Chen et al., 2008). The pain slide is a visual analog scale, ranging from *no pain* (1) to *hurts worst* (10), with corresponding facial expression drawings above points zero, two, four, six, eight, and ten. Participants indicated their emotional pain on the scale.

Need Threat Scale: The Need Threat Scale (see Appendix F) was developed by Williams et al. (2000) for use in the original Cyberball study to assess participants' feelings of social exclusion. The scale consists of five items and measures self-esteem (e.g., "I felt liked."), belongingness (e.g., "I felt rejected."), meaningfulness (e.g., "I felt invisible."), control (e.g., "I felt I had control."), and ostracism ("I felt ignored."). Participants responded to each statement using a scale ranging from *not at all* (1) to *extremely* (5) (Eisenberger et al., 2006; Riva et al., 2011). The Need Threat Scale was scored by first reverse-scoring the measures of self-esteem and control and then averaging participants' responses to all five items. Higher scores indicate greater feelings of threatened needs.

Additional Measures:

Demographics: Participants responded to questions assessing age, gender, and ethnicity.

Perceived Social Support: Perceived social support (see Appendix G) was measured using the Multidimensional Scale of Perceived Social Support (MSPSS; Zimet, et al., 1988). The MSPSS is a 12-item questionnaire assessing perceived social support. Participants responded to each item using a Likert-like scale ranging from *very strongly disagree* (1) to *very strongly agree* (7). The MSPSS has been found to be reliable (Cronbach's alpha was 0.88) and valid for an undergraduate population (Zimet et al., 1988). The MSPSS was scored by adding a participant's responses to all 12 items and

then dividing his or her score by 12, with higher scores indicating greater perceived social support.

Comfort food: During the online survey, participants completed a survey assessing their preferences regarding comfort foods. They were provided with a list of 22 foods and were asked to check off each food from the list that they considered to be a “comfort food.” This list and the procedure were adapted from Wagner et al., (2014).

Analytic Strategy- Main Research Questions

The outcome variables (negative mood and emotional pain) were analyzed with ANCOVAs and followed-up with *t*-tests.

A two-way repeated measures ANCOVA with one between-subjects factor (five levels of food condition) and one within-subjects factor (three time points) was conducted on negative-mood scores, with Time 1 negative mood as a covariate. A similar ANCOVA was conducted on emotional-pain scores, with Time 1 emotional pain as a covariate. Because the hypotheses specify particular comparisons but do not make a prediction about an overall effect, the overall ANCOVA results in each model were suppressed except for the mean-square-error terms, which were used in calculating the planned contrasts. Hypotheses were tested with planned contrasts [see Table 5 for planned contrast coefficients and Appendix H for an example of how these planned contrasts were calculated], as follows:

Hypothesis 1: Participants who consume a comfort food before the social-pain task (Condition 1) will report less distress and less emotional pain directly after the task

(Time 3) compared to participants who eat nothing and to those who receive nothing before the task (Conditions 3, 4, & 5): A planned contrast comparing Condition 1 to combined Conditions 3, 4, and 5 on negative-mood scores at Time 3, and a similar contrast on emotional-pain scores.

Hypothesis 2: Participants who receive a comfort food before the social-pain task (Condition 2) will report less distress and less emotional pain directly after the task (Time 3) compared to participants who eat nothing and to those who receive nothing before the task (Conditions 3, 4, & 5): Planned contrasts comparing Condition 2 to combined Conditions 3, 4, and 5 on negative-mood scores and emotional-pain scores at Time 3.

Hypothesis 3: Participants who consume a comfort food after the social-pain task (Condition 3) will report less distress and less emotional pain by the end of the study (Time 4) compared to participants who eat nothing during the study (Condition 5): Planned contrasts comparing Condition 3 to Condition 5 on negative-mood scores and emotional-pain scores at Time 4.

Hypothesis 4: Participants who consume a comfort food or receive a gift before the task (Conditions 1 & 2) will report similar amounts of distress (Time 3) immediately after the social-pain task. However, participants who consume a comfort food before the task (Condition 1) will report less emotional pain (Time 3) immediately after the social-pain task than participants who received a gift before the task (Condition 2): A planned

contrast comparing Condition 1 to Condition 2 on negative mood scores at Time 3, and a planned contrast comparing Condition 1 to Condition 2 on emotional pain at Time 3.

Hypothesis 5: Participants who consume a comfort food or receive a gift after the task (Conditions 3 & 4) will report a similar level of distress by the end of the study (Time 4). However, participants who consume a comfort food after the task (Condition 3) will report less emotional pain by the end of the study (Time 4) than will participants who received a gift after the task (Condition 4): A planned contrast comparing Condition 3 to Condition 4 on negative-mood scores at Time 4, and a planned contrast comparing Condition 3 to Condition 4 on emotional pain at Time 4.

Hypothesis 6: Participants who consume comfort food after the social-pain task (Condition 3) will report less distress and less emotional pain by the end of the study (Time 4) compared to participants who consume comfort food before the task (Condition 1): Planned contrasts comparing Condition 3 to Condition 1 on negative-mood scores and on emotional-pain scores at Time 4.

Analytic Strategy- Exploratory Analyses

For the exploratory Hypothesis 7, multiple regression was used to assess the independent effect of perceived social support on negative mood at Time 4, controlling for mood at Time 1. The model was tested by entering Time 1 mood in the first step and the one continuous individual difference variable (centered) in the second step. This tests for independent effects of perceived social support above and beyond effects of Time 1

moods. A similar model was used to test the effects of perceived social support on emotional pain at Time 4.

For exploratory Hypothesis 8, multiple regression was used to assess the independent and interacting effects of experimental condition (1 & 3 v. 5) and perceived social support on negative mood at Time 4, controlling for mood at Time 1. The model was tested by entering Time 1 mood in the first step, experimental condition and perceived social support in the second step, and their interaction in the third step. A similar model was used to test the effects of these two predictor variables on emotional pain at Time 4.

Results

Manipulation Check

All participants completed the Needs Threatened Scale after playing Cyberball. The average score on this scale for all 5 conditions was 3.94 (Condition 1: 3.88; Condition 2: 3.93; Condition 3: 3.93; Condition 4: 3.99; Condition 5: 3.99). Previous literature has shown an average score of 3.27 on the Needs Threatened Scale (Eisenberger et al., 2006). To determine whether there were any significant differences between the groups on this scale, an ANOVA with one between-subjects factor (5 levels of food condition) was conducted on participants' Needs Threatened Scale scores. No significant differences were found among the five conditions, $F(4, 142) = .126, p = .973$. Therefore, all participants felt equally excluded during the online game, and their feelings of exclusion are similar to those found in previous studies.

Main Hypotheses for Negative Mood and Emotional Pain

Two-way repeated measures ANCOVAs with one between-subjects factor (five levels of food condition) and one within-subjects factor (three time points) were conducted on negative mood scores, with Time 1 negative-mood score as a covariate, and separately on emotional-pain scores, with Time 1 emotional-pain score as a covariate. [See Table 7 for the means and standard deviations of self-reported negative-mood scores and self-reported emotional-pain scores for each condition. See Figure 3 a graph of the average negative mood for each condition at Time 4, and Figure 4 for the corresponding information for emotional-pain scores.] For negative mood, Mauchly's test indicated that sphericity had not been violated, $\chi^2(2) = 5.26, p = .07$. Therefore, the sphericity-assumed mean-square-error term and degrees of freedom were used for the planned contrasts involving negative mood, $MSE = 5.3 (df = 282)$. For emotional pain, however, Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 42.46, p < .001$. Therefore, for tests involving emotional-pain scores, degrees of freedom and the mean-square-error term were corrected using Greenhouse-Geisser estimates of sphericity, $MSE = 1.15 (df = 223.52)$.

Hypothesis 1. The planned contrasts testing Hypothesis 1 revealed that contrary to my prediction, there were no significant differences on negative mood immediately after the social-exclusion task (Time 3) between those who consumed their comfort food before the task (Condition 1) and those who did not eat anything or receive anything before the task (Conditions 3, 4, & 5), $t(282) = -.03, p = .49, d = .004$.

Similarly, there were no significant differences between conditions on emotional pain immediately after the social exclusion task (Time 3) for those who consumed their comfort food before the task (Condition 1) compared to those who did not eat anything or receive anything before the task (Conditions 3, 4, & 5), $t(223.52) = 1.13$, $p = .13$, $d = .15$.

Hypothesis 2. Contrary to predictions for both negative mood and emotional pain, the planned contrasts revealed no differences between those who received their gift of comfort food before the task (Condition 2) compared to those who did not eat anything or receive anything before the task (Conditions 3, 4, & 5), $t(282) = -.52$, $p = .23$, $d = .06$ for negative mood; $t(223.52) = -.87$, $p = .19$, $d = .12$ for emotional pain.

Hypothesis 3. As predicted, participants who consumed a comfort food after the social-exclusion task (Condition 3) reported less distressed and less emotional pain by the end of the study (Time 4) compared to those who received nothing to eat during the study (Condition 5), $t(282) = -3.03$, $p = .04$, $d = .39$ for negative mood and $t(223.52) = -3.4$, $p = .0004$, $d = .41$ for emotional pain.

Hypothesis 4. I predicted that participants who consumed their comfort food before the social pain task (Condition 1) would report similar levels of negative mood, but less emotional pain than would participants who received a gift of comfort food before the task (Condition 2), right after the social pain induction (Time 3). As predicted, there were no differences between participants in these two groups for negative mood, $t(282) = .39$, $p = .41$, $d = .05$, but contrary to predictions, participants who consumed their food did not

report less emotional pain than participants who received a gift of food (and in fact felt marginally more emotional pain), $t(223.52) = 1.6, p = .052, d = .18$.

Hypothesis 5. I also predicted different outcomes for negative mood and emotional pain at the end of the study (Time 4) for participants who consumed a comfort food after the task (Condition 3) compared to those who received a gift after the task (Condition 4). Although I did not expect differences in negative mood, the planned contrasts revealed that participants who consumed a comfort food after the social-exclusion task (Condition 3) reported less negative mood by the end of the study (Time 4) compared to those who received a gift of comfort food after the task (Condition 4), $t(282) = -2.03, p = .02, d = .24$. As predicted, participants who consumed a comfort food after the social exclusion task (Condition 3) reported less emotional pain by the end of the study (Time 4) compared to those who received a gift of comfort food after the task (Condition 4), $t(223.52) = -3.52, p = .0003, d = .47$.

Hypothesis 6. I predicted that participants who consumed comfort food after the social-exclusion task (Condition 3) would report less negative mood and less emotional pain at the end of the study (Time 4) compared to participants who consumed comfort food before the task (Condition 1). This prediction was not supported for negative mood, $t(282) = .73, p = .33, d = .16$, but it was supported for emotional pain, $t(223.52) = 4.83, p < .0001, d = .65$.

Exploratory Analyses

Regression analyses investigating the independent effect of perceived social support on negative mood, and separately on emotional-pain scores, by the end of the study (Time 4) revealed that after controlling for Time 1 negative mood, or emotional-pain scores, perceived social support did not independently predict negative mood ($\beta = -.01, p = .83$), and that perceived social support did not independently predict emotional pain ($\beta = .05, p = .28$), [See Table 8].

Regression analyses were also used to investigate the independent and interacting effects of experimental condition (1 & 3 v. 5) and perceived social support on negative moods by the end of the study (Time 4), controlling for mood at Time 1. Experimental condition ($\beta = -.06, p = .42$) and perceived social support ($\beta = -.01, p = .92$) did not show independent effects on negative mood. However, the interaction of experimental condition and perceived social support did significantly predict negative mood ($\beta = .26, p = .003$), [see Table 9]. Patterns indicated that for those who did not consume or receive a comfort food during the study (Condition 5), negative-mood scores worsened when perceived social support was high and improved when perceived social support was low. For those who consumed a comfort food during the study (Conditions 1 & 3), perceived social support did not appear to affect negative mood. Therefore, perceived social support does not appear to exert an effect when individuals are given a chance to consume their comfort food.

A similar regression model was run to investigate the independent and interacting effects of experimental condition (1 & 3 v. 5) and perceived social support on emotional pain at the end of the study (Time 4), again controlling for mood at Time 1. Emotional-pain scores by the end of the study (Time 4) were not significantly predicted by experimental condition ($\beta = -.05, p = .32$), perceived social support ($\beta = .11, p = .1$), or their interaction ($\beta = .01, p = .93$), [see Table 9].

Discussion

The results of Study 1 provide evidence for the utility of comfort food in reducing the pain that comes from social rejection. Additionally, these results clarify the conditions under which comfort food may be beneficial. In particular, findings suggest that comfort food is helpful when received after experiencing social pain but does not prevent negative moods or emotional distress when provided before individuals experience social pain. Results also suggest that the effects of comfort food extend beyond the positive feelings that may be associated with receiving an unexpected gift, because the food had to have been consumed by participants, not merely received by participants, for them to experience the positive benefits. These effects were shown in a controlled experiment in which social rejection was induced with an online ball-toss game, Cyberball, and a manipulation check confirmed that all participants did feel that they had been excluded from the game.

These results offer an explanation for the conflicting findings found in the comfort food literature, and in particular for research showing that comfort food did not

alleviate participants' general negative mood (Wagner et al., 2014). Current findings suggest that comfort food may simply be more effective for reducing a specific type of negative mood, social pain, than for reducing a general negative mood. This explanation is supported by findings from Troisi and colleagues (Troisi & Gabriel, 2011; Troisi et al., 2015), who found that individuals appear to automatically associate comfort food with their relationships to close others, that thinking about a comfort food can help reduce feelings of social pain, and that individuals appear to consume more comfort foods on days when they have experienced more loneliness.

Although these previous researchers found relationships between comfort food consumption and feelings of belongingness, they did not test experimentally whether consuming a comfort food immediately after experiencing rejection would reduce feelings of distress. Study 1 did so and confirms that it does. Participants who consumed a comfort food after being socially rejected reported less negative affect and emotional pain by the end of the study compared to those who received nothing during the study (Hypothesis 3), and compared to those who received a gift of comfort food after the social rejection task (Hypothesis 5).

I had predicted (Hypothesis 5) that eating comfort food after social rejection would reduce emotional pain, but not negative affect, compared to simply receiving a gift of comfort food. The fact that it reduced both forms of emotional response suggests that prior comfort food studies that only measured negative affect should not necessarily assume that the reason they failed to find an effect of comfort food was due to measuring

the wrong form of emotional response (e.g., Wagner et al, 2015). In fact, the same results were found for both emotion measures in nearly all of the analyses reported here. The main exception is that compared to eating comfort food before the social-exclusion task, eating it after the task significantly reduced emotional pain (supporting Hypothesis 6), but not negative affect (failing to support Hypothesis 6). This difference may stem from comfort food creating a larger drop in emotional pain immediately after consumption compared to general negative affect, but because the two measures agree on all other outcomes (except for a marginal effect where none was predicted in Hypothesis 4), it may not be sensible to draw conclusions from this anomaly.

According to Hypothesis 4, I did not expect differences in negative mood between participants who consumed comfort food before the task and those who received a gift of comfort food before the task, but I did expect participants who consumed the food to report less emotional pain than those who received it as a gift. As predicted, no differences were found for negative mood, but a puzzling effect was found for emotional pain. After the social exclusion task, those who ate their comfort food reported marginally higher, not lower, levels of emotional pain than those who merely received the gift of food. Perhaps receiving the gift of comfort food before experiencing social pain was helpful in reducing emotional pain by giving participants something distracting to think about or something pleasant to look forward to after completing the unpleasant social-exclusion task.

There is no other evidence from this study for any beneficial effects of eating (Hypothesis 1) or receiving (Hypothesis 2) comfort food before experiencing social rejection. Before abandoning the idea of comfort food as a preventive measure, as there is some research supporting this idea (Wagner et al, 2015), it is worth considering whether these findings might also be a result of this study's procedure. During and after the social exclusion task, participants' comfort food, whether it was the uneaten package or the leftover wrappers, was out of sight, which might have decreased participants' awareness of the food. Perhaps if participants could have seen their comfort food or been reminded of it, it might have led to less distress, similar to the results from Troisi and Gabriel (2011) in which participants experienced less feelings of loneliness when thinking about their comfort food.

The exploratory hypotheses, which focused on assessing the effects of individuals' levels of perceived social support on negative mood and emotional pain as well as its interaction with the comfort food conditions, were not supported overall. The one exception is that the interaction of experimental condition and perceived social support was significant for participants' negative mood by the end of the study. When participants did not receive or eat comfort food, their mood was influenced by their level of social support. But when participants consumed their comfort food, their mood was no longer affected by their level of perceived social support. Comfort food may have substituted for perceived social support and helped participants experience less social pain resulting from being socially excluded. If so, this might suggest the hypothesis that

lonely individuals are more likely to consume comfort food, or, perhaps, that they may emotionally benefit from doing so, even if they may not physically benefit from it.

Although the results of Study 1 provide evidence that consuming a comfort food can reduce emotional pain, I was unable to assess whether consuming a comfort food was effective by simply being a distraction from the negative feelings caused by being socially rejected. Although this may be the cause, the comfort-food-gift conditions suggest that this may not be the case. Receiving a gift of comfort food could give participants a sense of anticipation of being able to enjoy their comfort food—and perhaps to feel better—in the near future, which may lead to pleasant and distracting thoughts. Because participants in these conditions did not see similar benefits compared those who were able to consume a comfort food, this suggests that consuming a comfort food is probably more than a simple distraction. However, future research will need to be conducted to assess if a different distracting task, perhaps one unrelated to food, may be as beneficial as consuming a comfort food for reducing distress caused by social rejection.

These findings are also limited in that individuals were not provided with their own idiosyncratic comfort food. Instead, participants were pre-selected if they listed chocolate bars or potato chips among their comfort foods, but they were then all given either a Hershey's chocolate bar or a bag of Old Dutch potato chips, which may not be the particular brand or form of those foods that the individual typically finds comforting. An individual whose comfort food is dark chocolate or a different brand of chocolate bar

may not get a fully comforting benefit from milk chocolate candy. This is still a closer match to participants' own comfort foods than prior research that simply gave all participants chocolate candy, regardless of whether chocolate was their comfort food.

An additional limitation is the short-term, lab-based nature of this study. The purpose of this study was to determine whether consuming comfort food could reduce emotional pain immediately after social rejection, which required providing participants with a comfort food to consume directly after a social exclusion task. This method allowed me to test my hypotheses and to determine that comfort food does reduce distress following social rejection. However, this method may not capture individuals' comfort-food-eating behavior in their natural environment. The length of time that individuals feel socially rejected and the process of finding and then consuming their comfort food may lead comfort food to have different effects on individuals' mood. Troisi et al. (2015) did find that securely-attached individuals consumed more comfort food on days after feeling increased loneliness, suggesting that rejection in everyday life does lead to comfort-food eating. However, the results from the current study and those obtained by Troisi et al. (2015) cannot determine whether individuals who eat their comfort food on days after feeling more social pain are effectively reducing their distress.

Study 1 found that consuming a comfort food after being socially rejected alleviated the distress that results from threatened belongingness needs. These results add to the growing literature on the effectiveness of comfort food. Although comfort food might not reduce all forms of distress (Wagner et al., 2014), it appears that comfort food,

which is associated with feelings of belongingness (Troisi & Gabriel, 2011), can reduce feelings of social pain. Because of the evidence showing a strong connection between the social pain system and the physical pain system (Eisenberger, 2012; 2012b), I conducted Study 2 to determine whether comfort food might also reduce distress caused by physical pain.

Study 2

Study Design

Study 2 used a repeated-measures, between-subjects design. As in Study 1, all participants first completed an online survey one week before coming into the lab. During the 30-minute lab session, all participants completed the physical-pain induction. Additionally, participants completed surveys assessing distress and physical pain four times throughout the study: at the beginning of the study, before the physical-pain induction, after the physical-pain induction, and at the end of the study. [See Figure 2 for a description of the timeline and Appendix B for a step-by-step overview of the methods.] In Study 2, participants were randomly assigned to one of three conditions: (6)¹ receive pre-pain comfort food to consume, (7) receive pre-pain gift of food (no consumption), or (8) receive nothing during the study. [See Table 2 for a listing of these conditions.] All of the methods were approved by the IRB committee at the University of Minnesota, and the study design was pre-registered with the Open Science Framework.

Study 2 did not include post-pain comfort food conditions due to ethical constraints and the nature of physical pain. Although the distressing effects of social pain

have been shown to last even after the task that caused the social pain has ended, the distressing effects of physical pain should not continue at as large of a magnitude after the physical pain induction has ended. All participants, regardless of whether they received food to eat, were meant to experience decreases in pain immediately after the task ends to ensure participants did not endure excessive harm or discomfort during the study. Therefore we could not assess whether comfort food, eaten or received, would reduce physical pain after the task.

Main Research Questions and Predictions:

Because of the overlap between the social attachment system and the physical pain system, researchers have found that similar treatments, such as taking acetaminophen (DeWall et al., 2010) or receiving social support (Eisenberger et al., 2011b), reduce both physical and social pain. Therefore, participants in the three different conditions in Study 2 should show similar results as participants in their matching conditions from Study 1, with identical reasoning for the hypotheses. Because of the similarities between social pain and physical pain, only the research questions and hypotheses for Study 2 are listed below, including in the exploratory hypotheses section. [See Table 4 for an overview of all hypotheses.]

- 1) *Will eating a comfort food before the physical-pain induction (Condition 6) prevent reported distress and physical pain directly after pain is induced (Time 4) compared to eating and receiving nothing before the pain induction (Condition 8)?*

Hypothesis 1: Participants who consume a comfort food before the physical-pain induction (Condition 6) will report less distress and physical pain (Time 4) compared to participants who eat nothing and receive nothing before the pain is induced (Condition 8).

- 2) *Will receiving a gift of food before the physical-pain induction (Condition 7) prevent reported distress and physical pain directly after pain is induced (Time 4) compared to eating and receiving nothing before the pain induction (Condition 8)?*

Hypothesis 2: Participants who receive a comfort-food gift before the physical-pain induction (Condition 7) will report less physical pain and distress directly after the task (Time 4) compared to participants who eat nothing and receive nothing before the task (Condition 8).

- 3) *Will eating a comfort food before the physical-pain induction (Condition 6) lead to less distress and physical pain directly after the pain is induced (Time 4) compared to receiving a gift before the pain induction (Condition 7)?*

Hypothesis 3: Participants who consume a comfort food or receive a gift before the physical-pain induction (Conditions 6 & 7) will report similar levels of distress after the pain induction (Time 4), but participants who consume a comfort food before the pain is induced (Condition 6) will report less physical pain after the pain induction (Time 4) compared to participants who receive a comfort food gift (Condition 7).

Exploratory Questions & Predictions:

- 4) *Will participants who have an overall greater level of social support in their lives, regardless of condition, report less distress and pain by the end of the study (Time 4)?*

Hypothesis 4, Exploratory: The more social support participants report having in their lives, the less distress and physical pain they will report by the end of the study (time 4).

- 5) *Will social support level interact with the manipulations (Conditions 6 v. 8) in predicting distress and physical pain by the end of the study (Time 4)?*

Hypothesis 5, Exploratory: Social support will interact with experimental condition such that the lower the level of social support, the less distress and physical pain participants who consume a food (Condition 6) will be in by the end of the study (Time 4) compared to participants who do not consume a food (Condition 8).

Participants:

A total of 90 University of Minnesota students (78 women, 12 men,) participated in this study for \$10.00 or for extra credit in their psychology courses. With 30 subjects per condition, a prior power analyses indicated that I would be able to detect an effect of size .64 with a power of 0.80. As in Study 1, individuals were eligible for the study if they indicated that chocolate bars or potato chips were a comfort food. All participants were 18 years old or older, and the average age was 20.2 years old. The majority of the

participants were white (70%), followed by Asians (17.8%), and others (12.2%). Two participants were dropped from the study due to methodological errors: One participant refused the gift of chocolate and another did not understand the instructions during the pain-threshold and pain-tolerance task. Therefore, the final number of participants included in the analyses was 88; with 4 men and 25 women in Condition 6, 4 men and 25 women in Condition 7, and 4 men and 26 women in Condition 8.

Procedure:

Participants responded to recruitment fliers around campus as well as to postings on the Psychology Department's experiment sign-up website for a study ostensibly investigating "the effects of glucose on everyday tasks." The recruitment for Study 2 was under the same name and description as Study 1 to guarantee that participants from Study 1 would not be able to participate in Study 2. When participants contacted the lab to schedule a study session, they were provided with the same pre-screening online survey link. If participants indicated that chocolate bars or potato chips were a comfort food, then a research assistant contacted them to schedule a lab session for one week after they completed the online survey. Before arriving, participants were randomly assigned to one of the three conditions: (6) receive pre-pain comfort food to consume, (7) receive pre-pain gift (no consumption), or (8) receive nothing during the study. All participants were run in individual sessions.

After participants first arrived at the lab, they learned about the purpose of the study. Research assistants explained to participants:

“We are interested in learning more about how glucose affects social interactions, including learning about how the individual feels before, during, and after these interactions. We are interested in this topic because of the increase in snacking, especially sweet snacks, over the last decade, and an increase in snacking means more people are interacting with others immediately after consuming a glucose-rich snack. We have chosen a pressure task as our lab version of many daily activities. Many common tasks we must complete on a day-to-day basis cause discomfort—either physically or emotionally—and the pressure task is one way to induce this discomfort safely in the lab. The overall discomfort from this task is similar to having your blood pressure measured by a blood-pressure cuff. During this task, I will use a device to exert pressure behind your thumb on your non-dominant hand. This is a safe and common task used in psychological studies. I will explain this procedure in more detail once we get to that portion of the study.”

After explaining the purpose of the study, research assistants had participants read and sign the consent form. Additionally, research assistants answered participants’ questions. Next, research assistants placed participants at the computer that was used during the study and provided them with an overview of the study:

“The majority of the study will take place on this computer. At different times throughout the study, you will need to inform me that you are ready for the next task. The computer will alert you when it is time to come get me. Do NOT continue on with

the study until I inform you that it is okay to continue. Do you UNDERSTAND??? I'll be right outside this door in the next room.

“Before you begin any portion of the study, I will do a short demo to show you how the pressure device works. After this, you'll begin the study. First, you'll complete a few measures to assess how you are feeling before completing any tasks. Next, you'll alert me that you're ready for the next part of the study. I will return to help you complete the first pressure task. Following the pressure task, you will complete a few questionnaires. Next, you may or may not receive a glucose-rich snack followed by additional questionnaires. After this portion, you'll again alert me that you're ready for the second pressure task. This task will be administered more than once to more accurately reflect daily life. Next, you'll complete questionnaires so we can learn how you are feeling after this task. Finally, you'll complete the last questionnaires. Do you have any questions regarding the process for this study?”

After research assistants ensured that participants understood the procedures, they left the room to allow participants to begin the study. Participants completed the Time 1 measures: the PANAS and the physical-pain slide. These measures assessed participants' current mood and perceived physical pain levels. Immediately after participants finished the questionnaires, the computer presented a message to participants that they should alert the research assistants that they were ready for the next part of the study. Research assistants informed participants that this was the first of two pressure tasks. Research assistants administered the physical-pain induction, using a pressure algometer, to obtain

participants' baseline measures of pain tolerance and pain threshold. (More detailed information regarding the physical-pain induction is provided below.) Directly following the baseline measures, participants returned to the computer to complete the mood and physical-pain measures (Time 2).

After participants completed the questionnaires, the computer displayed a message that prompted the participant to alert the research assistant that he or she had finished with this portion of the study and was ready for the next part. Then, research assistants provided participants with a milk chocolate bar or a small bag of potato chips, depending on their preferences indicated on the online survey, and asked them to eat it (Condition 6), gave participants their comfort food as a gift but asked them not to eat it until after the study was over and to simply sit quietly (Condition 6), or asked participants to simply sit quietly (Condition 7). The research assistants left the participants alone for three minutes to eat their comfort food or to sit quietly. Immediately following the three-minute time block, the research assistants informed participants that it was time to continue with the surveys on the computer. Participants completed the PANAS and the pain slide (Time 3). Again, the computer displayed a message that prompted the participant to inform the research assistant that he or she was ready for the next part of the study, which was the physical-pain task.

Immediately following the pain induction, participants again completed physical-pain and mood measures (Time 4). Following these measures, participants explained in their own words what they thought the study was about and whether they were suspicious at

any point during the study. Finally, research assistants debriefed the participants and ensured that no participants felt distressed before leaving the lab.

Stimuli

Comfort food: Research assistants provided participants in the comfort-food conditions (6 & 7) with the same options from Study 1: either a milk chocolate bar or a small bag of potato chips. The rationale for choosing these snacks was the same as in Study 1; participants are young adults who tend to prefer snack foods for comfort foods. Additionally, the online survey pre-screened participants to ensure that they preferred either chocolate bars or potato chips as a comfort food.

Pain stimuli: All Study 2 participants completed the physical-pain task. Research assistants used a pressure algometer, which applies pressure to muscle or bone, to obtain participants' baseline measures (to control for individual differences in pain experience) and to induce pain during the physical-pain task. Pressure algometers have been used successfully in previous social-exclusion and physical-pain research (Berstein & Claypool, 2012; DeWall & Baumeister, 2006). Research assistants used the Wagner FPX algometer to measure pain threshold—the initial point an individual feels pain—and pain tolerance—the maximum level of pain an individual can withstand. The procedure closely followed the procedures previously used by Berstein and Claypool (2012) and DeWall and Baumeister (2006).

Before beginning the pressure task, research assistants informed participants that this task was being used to help mimic many day-to-day tasks that cause mild discomfort.

During this task, participants and research assistants sat in adjacent chairs. Research assistants applied steady pressure at a rate of 5 kilopascal (kPa) per second perpendicularly to participants' non-dominant hand at the first dorsal interosseous muscle (i.e., behind the first knuckle of the index finger). Pain-threshold and pain-tolerance measures were counterbalanced with a 90-second interval between the two measures to prevent habituation. To measure pain threshold, research assistants told participants to say "now" when they first experienced pain due to the pressure. To measure pain tolerance, research assistants told participants to say "stop" when the pain from the pressure became so uncomfortable that the participant did not wish to continue. In both cases, research assistants stopped immediately, and the pressure algometer recorded the amount of pressure that was applied. For the baseline measures, research assistants conducted one trial of pain-tolerance and pain-threshold measures. The baseline measures were used to control for participants' individual pain tolerance and threshold levels. The second pressure task contained the measures used to compare the different conditions. For this second set of measures, research assistants conducted three trials of pain-tolerance and pain-threshold measures.

Measures

Dependent Variables:

PANAS: As in Study 1, I used the PANAS (see Appendix D) to measure mood. For a detailed description of the PANAS, please see Study 1 measures.

Physical-Pain Slide: As in Study 1, I used the pain slide (see Appendix E) to measure pain. Participants indicated their physical pain on this visual analog scale. For a detailed description of this measure, please see Study 1 measures.

Pain Threshold: Pain threshold is the initial point an individual feels pain. Participants said “now” when they began to feel pain from the amount of pressure on their hand. The pressure algometer automatically recorded the amount of pressure that participants first found painful. The three pain-threshold trials are averaged together to create a single pain-threshold score for each participant.

Pain Tolerance: Pain tolerance is the maximum level of pain an individual can withstand. Participants said “stop” when they could no longer withstand the amount of pressure on their hand. The pressure algometer automatically recorded the amount of pressure that participants withstood. The three pain-tolerance trials were averaged together to create a single pain-tolerance score for each participant.

Additional Measures:

Demographics: Participants responded to questions assessing age, gender, and ethnicity.

Perceived Social Support: The same measure of perceived social support as in Study 1 was used (see Appendix G). For more information, please see the additional measure in Study 1.

Comfort food: As in Study 1, participants completed an online portion of the study during which they completed a survey requiring them to check off each food from a list of 22 foods that they considered to be a “comfort food.”

Analytic Strategy- Main Research Questions

The negative-mood and physical-pain data were analyzed with ANCOVAs and followed-up with planned contrasts. Two-way repeated measures ANCOVAs with one between-subjects factor (three levels of food condition) and one within-subjects factor (three time points) were conducted on negative-mood scores, with Time 1 mood as a covariate, and separately for physical-pain scores, with Time 1 physical pain as a covariate. Because the hypotheses specify particular comparisons but do not make a prediction about an overall effect, the overall ANCOVA results were suppressed except for the mean-square-error term from each analysis, which were used in calculating the planned contrasts. Hypotheses were tested with planned contrasts [see Table 6 for planned contrast coefficients], as follows:

Hypothesis 1: Participants who consume a comfort food before the physical-pain induction (Condition 6) will report less distress and less physical pain (Time 4) compared to participants who eat nothing and receive nothing before the pain is induced (Condition 8): Planned contrasts comparing Condition 6 to Condition 8 on negative-mood scores and on physical-pain scores at Time 4.

Hypothesis 2: Participants who receive a comfort food gift before the physical-pain induction (Condition 7) will report less distress and less physical pain directly after the

task (Time 4) compared to participants who eat nothing and receive nothing before the task (Condition 8): Planned contrasts comparing Condition 7 to Condition 8 on negative-mood scores and on physical-pain scores at Time 4.

Hypothesis 3: Participants who consume a comfort food or receive a gift before the physical-pain induction (Conditions 6 & 7) will report similar levels of distress and similar levels of physical pain after the pain induction (Time 4): Planned contrasts comparing Condition 6 to Condition 7 on negative-mood scores and physical-pain scores at Time 4.

The same hypotheses will also be tested for pain tolerance and pain threshold, although these variables were only measured at time 1 and time 4, so the models are slightly different. One-way ANCOVAs with the between-subjects factor (three levels of food condition) were conducted on participants' average pain-threshold and pain-tolerance scores (separately), with the relevant Time 1 baseline measure as a covariate. If the overall ANCOVAs are significant, planned contrasts similar to above would be conducted for pain threshold and for pain tolerance, and the mean-square-error term (from the appropriate ANCOVA) will be used to calculate those contrasts [see Table 6 for planned contrast coefficients].

Analytic Strategy- Exploratory Analyses

For exploratory Hypothesis 4, multiple regression was used to assess the independent effect of perceived social support on negative-mood scores at Time 4, controlling for mood at Time 1. I do not have hypotheses involving interactions between these variables.

The model was tested by entering Time 1 mood scores in the first step and the one continuous individual difference variable (centered) in the second step. This way I can test for independent effects of perceived social support above and beyond effects of Time 1 mood. A similar model was used to test the effects of perceived social support on physical pain at Time 4. Similar models were used to test the effect of perceived social support on participants' pain tolerance and pain threshold at Time 4.

For exploratory Hypothesis 5, multiple regression was used to assess the independent effects of experimental condition (Conditions 6 v. 8) and perceived social support on negative mood at Time 4, controlling for mood at Time 1. The model was tested by entering Time 1 negative-mood scores in the first step, experimental condition and perceived social support in the second step, and their interaction in the third step. A similar model was used to test the effects of these two predictor variables on physical pain at Time 4, average pain threshold scores, and average pain tolerance scores (separately).

Results

Self-Reported Negative Mood Scores

A two-way repeated measures ANCOVA with one between-subjects factor (three levels of food condition) and one within-subjects factor (three time points) was conducted on negative-mood scores, with Time 1 mood as a covariate. [See Table 10 for the means and standard deviations of negative mood scores for each condition.] Mauchly's test indicated that the assumption of sphericity had been violated, $\chi^2(2) = 6.7, p = .04$.

Therefore, degrees of freedom and the mean-square-error term were corrected using Greenhouse-Geisser estimates of sphericity, $MSE = 2.04$ ($df = 155.9$).

Hypothesis 1. The planned contrast testing Hypothesis 1 revealed that contrary to predictions, there was no significant difference on negative mood between those who consumed a comfort food (Condition 6) and those who did not eat or receive any food during the study (Condition 8), $t(155.9) = 1.06$, $p = .15$, $d = .14$.

Hypothesis 2. The planned contrast testing Hypothesis 2 revealed significant differences on negative mood between those who received a gift of comfort food (Condition 7) and those who received no food during the study (Condition 8), but the results were in the opposite direction as predicted, $t(155.9) = 1.8$, $p = .04$, $d = .21$. Those who received a gift of comfort food (Condition 7) were more distressed than those who did not eat or receive a comfort food (Condition 8). Perhaps those who received a gift of comfort food were frustrated because they were not allowed to eat a food they like, which enhanced the distress caused by the pressure task.

Hypothesis 3. As predicted, the planned contrasts revealed no differences on participants' negative mood between those who consumed a comfort food (Condition 6) and those who received a gift of comfort food (Condition 7), $t(155.9) = -.74$, $p = .23$, $d = .09$.

Self-reported physical-pain scores

A two-way repeated measures ANCOVA with one between-subjects factor (three levels of food condition) and one within-subjects factor (three time points) was conducted

on physical-pain scores, with Time 1 physical-pain scores as a covariate. [See Table 10 for the means and standard deviations of physical-pain scores for each condition.]

Mauchly's test indicated that sphericity had not been violated, $\chi^2(2) = 1.28, p = .53$.

Therefore, the sphericity-assumed mean-square-error term and degrees of freedom were used for the planned contrasts, $MSE = .48 (df = 168)$.

Hypothesis 1. Similar to the results for negative mood, the planned contrasts testing Hypothesis 1 revealed no significant differences on physical pain between those who consumed their comfort food (Condition 6) and those who did not consume or receive any food during the study (Condition 8), $t(168) = 1.43, p = .08, d = .22$.

Hypothesis 2. The planned contrasts testing Hypothesis 2 revealed a significant difference on physical pain between those who received comfort food as a gift (Condition 7) and those who did not eat or receive a comfort food (Condition 8), $t(168) = 2.19, p = .01, d = .30$. However, the difference found was in a direction opposite than predicted; those who received a gift of comfort food (Condition 7) reported more physical pain than did those who did not eat or receive a comfort food (Condition 8). These results mirror the results comparing these two groups on self-reported negative distress. Therefore, the same reasoning, that participants who received a gift of comfort food were more frustrated, might help provide an explanation for this unexpected finding.

Hypothesis 3. Contrary to predictions, there were no significant differences on physical pain between those who consumed their comfort food (Condition 6) and those who received a gift of comfort food (Condition 7), $t(168) = -.76, p = .22, d = .10$.

Pain Threshold and Pain Tolerance

One-way ANCOVAs with one between-subjects factor (three levels of food condition) were conducted on participants' average pain-threshold scores, with their baseline threshold measure as a covariate, and on participants' average pain-tolerance scores, with their baseline tolerance measure as a covariate. There was no significant effect of condition on participants' average pain-threshold scores, $F(2, 84) = 2.24, p = .11, d = .05$, and therefore none of the three hypotheses regarding pain threshold were supported. Similarly, there were no significant differences among the three conditions in participants' average pain-tolerance scores, $F(2, 84) = .313, p = .73, d = .007$. Therefore, none of the three hypotheses were supported for pain tolerance, either. [See Table 10 for the means and standard deviations of average pain threshold scores and average pain tolerance scores for each condition.]

Exploratory Analyses

Regression analyses investigating the independent effect of perceived social support revealed that perceived social support did not independently predict: negative moods by the end of the study (Time 4; $\beta = -.08, p = .34$); physical pain by the end of the study (Time 4; $\beta = -.06, p = .46$); average pain-threshold scores ($\beta = -.03, p = .67$); or average pain-tolerance scores ($\beta = .03, p = .52$). [See Table 11 for results for self-reported negative mood and self-reported physical pain. See Table 12 for results for average pain threshold and average pain tolerance scores].

Regression analyses were also used to investigate the independent and interacting effects of experimental condition (Conditions 6 v. 8) and perceived social support on negative-mood scores by the end of the study (Time 4), controlling for mood at Time 1. Experimental condition did not show independent effects on negative mood ($\beta = -.04, p = .67$), but perceived social support did show independent effects on negative mood ($\beta = -.29, p = .04$). The pattern of results for the main effect of perceived social support suggests that the more social support participants reported having in their lives, the lower their negative mood, that is their mood with less negative, at the end of the study. The interaction between condition and perceived social support was non-significant ($\beta = .11, p = .41$), [see Table 13].

Similar regression analyses were used to investigate the independent and interacting effects of experimental condition (Conditions 6 v. 8) and perceived social support on physical pain by the end of the study (Time 4), controlling for physical pain at Time 1. Physical pain by the end of the study (Time 4) was not significantly predicted by experimental condition ($\beta = -.02, p = .87$), perceived social support ($\beta = .03, p = .83$), or their interaction ($\beta = -.12, p = .4$), [see Table 15].

Additionally, separate regression analyses were used to investigate the independent and interacting effects of experimental condition (6 v. 8) and perceived social support on average pain threshold and average pain tolerance, controlling for baseline pain threshold and baseline pain tolerance, respectively. Average pain threshold was significantly predicted by condition ($\beta = -.15, p = .04$), indicating that participants who consumed their

comfort food had slightly higher pain thresholds compared to those who did not consume a comfort food during the study. Average pain threshold was not significantly predicted by perceived social support ($\beta = -.01, p = .95$) or the interaction between condition and perceived social support ($\beta = -.11, p = .25$). Average pain tolerance was not significantly predicted by experimental condition ($\beta = -.04, p = .47$), perceived social support ($\beta = .08, p = .29$), or their interaction ($\beta = -.06, p = .4$), [see Table 15].

Discussion

Study 2 found that eating comfort food prior to experiencing pain did not improve participants' moods, reduce their physical pain, or increase their pain tolerance or pain threshold. In addition, this study unexpectedly found negative effects of receiving a gift of comfort food prior to experiencing pain. In contrast to Study 1, there were no conditions in which participants received a gift of comfort food or consumed comfort food after the task.

No significant differences in negative mood or physical pain (including pain tolerance and pain threshold) were found between those who consumed a comfort food and those who did not receive or consume anything during the study (Hypothesis 1), or between those who consumed a comfort food and those who received a comfort food (although it should be noted that for this latter hypothesis, Hypothesis 3, I did not predict a difference in mood between those two groups).

These results are similar to the pattern of results found in Study 1 for the pre-task comfort food conditions. In Study 1, consuming or receiving a comfort food before the

social-pain task was not protective; participants in these conditions did not report less negative mood or emotional pain compared to those who received nothing before the task. Because physical pain and social pain can be reduced or enhanced by the same factors (e.g., taking acetaminophen) (DeWall et al., 2010) or having social support (Eisenberger et al., 2011b), it is not surprising that if comfort food was ineffective before a social-pain task, it would also be ineffective before a physical-pain task. Therefore, the same methodological concerns from Study 1 might also be influencing the results from Study 2. Specifically, the comfort food, whether it was the packaged gift or the empty wrapper, was hidden from sight during the physical-pressure task, potentially decreasing participants' awareness of their comfort food. Providing participants with an external cue, such as the comfort-food wrapper, to remind them of their comfort food during the pressure task might have led to different results. In addition, it is possible that no results were found because the pain induction was not potent enough. For ethical reasons, the pressure task was designed to induce brief pain and not cause long-lasting discomfort to ensure that participants did not experience excessive harm during the study. Therefore, participants may not have experienced enough pain or experienced pain for long enough to allow comfort food to provide any improvement.

Hypothesis 2 predicted that those who received a gift of comfort food would experience less distress and less physical pain than those who received nothing, but those who received a gift reported more negative mood and more physical pain than those who received nothing. It had been predicted that a gift of comfort food would lead to less

distress compared to not receiving any food during the study because thinking about the gift may have provided a distraction from the pain (McCaul & Malott, 1984). The gift of comfort food may not have been a big enough distraction, or as suggested above, the gift may have frustrated participants. Participants' moods may have worsened when not allowed to consume their comfort food, which could have enhanced the distress felt during the pressure task.

The exploratory analyses assessed the interacting effects of individuals' levels of perceived social support and the experimental conditions (consuming vs. not receiving comfort food) on negative mood, physical pain, average pain threshold, and average pain tolerance. The majority of these independent and interacting effects were non-significant, with two exceptions. Participants who felt they had more social support in their lives had lower negative-mood scores by the end of the study, suggesting that social support might be protective against the negative moods caused by physical pain. However, perceived social support did not have a significant effect on the other three dependent variables. Because these were exploratory hypotheses, results must be interpreted carefully, and future research will be necessary to determine the relationships among perceived social support, comfort food, and feelings of negative mood resulting from physical pain.

The second significant result from the exploratory analyses was a significant effect of experimental condition (consuming vs. not receiving comfort food) on pain threshold, found in the model that included social support as well as the interaction of condition and social support. The pattern of results suggest that those who consumed a

comfort food had slightly higher pain thresholds, meaning that they could endure pain for slightly longer, compared to those who did not receive or eat a comfort food during the study. These results support the main hypotheses that predicted that consuming a comfort food would be protective. However, that part of the analysis is similar to Hypothesis 1, which was analyzed using an ANCOVA (without incorporating social support), and which found no significant differences between conditions for participants' pain-threshold scores. These conflicting results suggest that perhaps controlling for social support and its interaction with experimental condition in the regression model allowed that model to account for just enough additional error variance that a small effect of condition on pain threshold was able to emerge. Due to the small effect size of this result, as well as it appearing only in an exploratory analysis, it should be considered tentative and in need of replication before giving it much credence.

Overall, the majority of the hypotheses for Study 2 were not supported, suggesting that comfort food may not be an effective method for preventing physical pain. However, due to the similarities between the physical pain system and the social pain system (Eisenberger, 2012; 2012b), these results are not surprising given the evidence that comfort food was also ineffective for preventing social pain. Comfort food might help reduce distress resulting from physical pain if it is consumed immediately after the pain-inducing incident (although individuals in serious pain are not likely to be eager to eat at that moment), but due to ethical constraints, I was unable to test this hypothesis. The physical pain induced in the lab was enough to cause momentary

discomfort, but the goal was to ensure that participants would not experience lingering physical pain once the task was over. Therefore, it seems unlikely that researchers could adequately assess the use of comfort food to reduce physical pain in a laboratory setting. Future research could focus on taking advantage of real world events in which individuals are already experiencing physical pain, such as injuries at a sporting event, to assess if comfort food could reduce distress stemming from physical pain.

These findings (or, rather, the lack of effects) may only apply to women, as only a small number of men participated in the study. It seems unlikely, however, that men would have a stronger or more powerful response to comfort food than would women, and prior research has not found gender differences. Additionally, this study contains the same limitations as Study 1 in regards to the type of food provided. Participants were provided with their indicated comfort food, but the specific brand might not have been what was preferred by each participant.

General Discussion

The purpose of these studies was to determine whether comfort food could reduce distress resulting from social exclusion or physical pain, and comfort food was effective for the pain of social exclusion, but not for physical pain. After being socially rejected, participants who consumed a comfort food had reduced amounts of negative mood and emotional pain. This effect was due to eating the food, and not due to the pleasure of receiving an unexpected treat, because participants who received a gift of food felt just as distressed as participants who did not receive their comfort food. In addition, comfort

food did not effectively prevent the pain of social exclusion, nor did it prevent physical pain. For physical pain, it still may be the case that comfort food would help individuals if they received it while they were in pain, but it was not possible to test that here.

Comfort food, commonly assumed to improve mood, has not been consistently shown to alleviate overall negative affect. Wagner et al. (2014) found that comfort food was no better at improving general negative affect than an equally-liked food, a neutral food, or nothing, leading to the conclusion that the belief that comfort food can reduce negative mood may be a myth. In contrast, Troisi and colleagues (Troisi & Gabriel, 2011; Troisi et al., 2015) found that individuals automatically associate comfort food with close relationships and that securely-attached participants consume more comfort food on days after they have experienced more feelings of loneliness than usual. Their results suggested that comfort food might be beneficial for the specific type of distress experienced after social rejection. The current set of studies are the first, to my knowledge, to directly assess whether comfort food could immediately reduce distress caused by social rejection. The results from Study 1 along with previous research suggests that comfort food is not a panacea for general distress but, instead, may well reduce distress caused by threats to belongingness needs.

These studies were not designed to test *how* comfort food leads to reduced distress, but that question is of great interest. One possible explanation for the effectiveness of comfort food is that the act of consuming a comfort food leads to immediate biochemical changes, such as increases in dopamine (Small et al. 2003), that

can suppress physical pain (Eisenberger, 2008). Because physical and emotional pain are thought to use the same system, dopamine should also suppress emotional pain. This idea did not receive much support here. Dopamine release, if it had happened, was expected to reduce physical pain, and yet we found no effects on physical pain. In addition, dopamine release was only expected to reduce emotional pain, not negative affect, after the social-exclusion task (Eisenberger, 2008), but we found beneficial effects of eating comfort food on both outcomes. Future research may wish to specifically measure the release of dopamine following comfort food consumption to determine if this remains a likely mechanism.

Additionally, the current studies did not have any control conditions in which participants consumed a non-comfort food. Therefore, I could not assess if consuming a comfort food reduces distress due to some specific component of comfort food or if it is the process of eating any liked food that is reducing distress. Comfort food might be reducing distress simply through the process of eating, and any food might be able to reduce feelings of social pain. However, the automatic association between comfort foods and social relationships (Troisi & Gabriel, 2011) suggests that comfort food has a unique ability to improve distress after being socially rejected.

Overall, participants reported less negative mood and emotional pain when they consumed a comfort food after being socially rejected, but it still remains possible that there are individual differences that moderate these effects. The one tested here, perceived social support, by and large did not moderate the effects found here. One

individual difference variable that may be relevant here is attachment style. Troisi et al. (2015) found that participants were more likely to rate a comfort food positively after being socially rejected and were more likely to consume comfort food on days in which they had experienced more social rejection, but only for securely-attached participants. These results suggest that comfort food might be even more effective for those who are securely attached, perhaps because securely-attached individuals have more positive feelings associated with close relationships (Shaver & Hazan, 1987; Kobak & Sceery, 1988). Future research could measure participants' attachment styles to assess whether the results are altered when including this moderator.

Another possible moderator could be individuals' personal beliefs regarding comfort food. Comfort food appears to be a ubiquitous belief in American culture, but not all cultures hold this belief. For example, Ong, IJzerman, and Leung (2015) conducted a replication of Troisi and Gabriel's 2011 study but with participants from America, the Netherlands, and Singapore. Ong et al. (2015) found that their American sample replicated the original results, but the Dutch and Singaporean participants did not have the same association between comfort-food consumption and social relationships. Therefore, comfort food may only reduce social pain for those who believe comfort food is a method for reducing distress after being socially rejected.

The results from Study 1 suggest that comfort food may be an easy and inexpensive way to reduce negative emotions caused by social exclusion. Many people already automatically reach for their comfort food when distressed and others could be

easily taught to find their comfort food to improve their mood after feeling lonely. Being able to easily and quickly reduce feelings of social pain is important because of the negative health consequences associated with long-term social exclusion (Alvares et al., 2010), but eating comfort food, which is often unhealthy (Wansink et al., 2003) leads to other health concerns. Future interventions could focus on determining other methods, which are just as easy and inexpensive, to reduce social pain, or on training people to select healthier foods when they want comfort (as well as testing whether healthier comfort foods would be effective). The difficulty lies in determining how to help people trade the easy and enjoyable behavior of consuming a comfort food to improve mood for a different, healthier, activity.

The ability of comfort food to repair a negative mood is a widely held belief in American culture. Although comfort food may not reduce all forms of negative mood, such as a general negative mood or distress arising from physical pain, the results from these studies suggest that comfort food can soothe the rejected soul.

Table 1

Study 1 Participant Conditions

	Study 1: Social Exclusion
Pre-Pain Comfort Food	1
Pre-Pain Gift Control	2
Post-Pain Comfort Food	3
Post-Pain Gift Control	4
Nothing	5

Table 2

Study 2 Participant Conditions

	Study 2: Physical Pain
Pre-Pain Comfort Food	6
Pre-Pain Gift Control	7
Post-Pain Comfort Food	-
Post-Pain Gift Control	-
Nothing	8

Table 3

Study 1 Hypotheses

Study 1
<p>Hypothesis 1: Participants who consume a comfort food before the social pain task (1) will report less distress and emotional pain directly after the task (Time 3) compared to participants who eat nothing and to those who receive nothing before the task (3, 4, & 5).</p>
<p>Hypothesis 2: Participants who receive a comfort food before the social pain task (2) will report less emotional pain and distress directly after the task (Time 3) compared to participants who eat nothing and to those who receive nothing before the task (3, 4, & 5).</p>
<p>Hypothesis 3: Participants who consume a comfort food after the social pain task (3) will report less distress and emotional pain by the end of the study (Time 4) compared to participants who eat nothing during the study (5).</p>
<p>Hypothesis 4: Participants who consume a comfort food before the task (1) will report similar amounts of distress but less emotional pain after the pain induction (Time 3) compared to those who receive a gift before the task (2).</p>
<p>Hypothesis 5: Participants who consume a comfort food after the task (3) will report a similar level of distress but less emotional pain at the end of the study (Time 4) compared to those who receive a gift after the task (4).</p>
<p>Hypothesis 6: Participants who consume comfort food after the social pain task (3) will report less distress and pain by the end of the study (Time 4) compared to participants who consume comfort food before the task (1).</p>

Table 4

Study 2 Hypotheses

Study 2
Hypothesis 1: Participants who consume a comfort food before the physical pain induction (6) will report less distress and physical pain (Time 4) compared to participants who eat nothing and receive nothing before pain is induced (8).
Hypothesis 2: Participants who receive a comfort food gift before the physical pain induction (7) will report less physical pain and distress directly after the task (Time 4) compared to participants who eat nothing and receive nothing before the task (8).
Hypothesis 3: Participants who consume a comfort food before the physical pain induction (6) will report similar levels of distress but less physical pain after the pain induction (Time 4) compared to participants who receive a comfort food gift (7).

Table 5

Study 1, Analytic Strategy-Main Research Questions: Planned Contrast Coefficients for the two-way repeated measures ANCOVA on self-reported mood and emotional pain scores.

	Condition 1	Condition 2	Condition 3	Condition 4	Condition 5
Hypothesis 1	3	0	-1	-1	-1
Hypothesis 2	0	3	-1	-1	-1
Hypothesis 3	0	0	1	0	-1
Hypothesis 4	1	-1	0	0	0
Hypothesis 5	0	0	1	-1	0
Hypothesis 6	1	0	-1	0	0

Table 6

Study 2, Analytic Strategy-Main Research Questions: Planned Contrast Coefficients for the two-way repeated measures ANCOVA on self-reported mood and physical pain scores and on pain tolerance and pain threshold scores.

	Condition 6	Condition 7	Condition 8
Hypothesis 1	1	0	-1
Hypothesis 2	0	1	-1
Hypothesis 3	1	-1	0

Table 7

Study 1, Means and Standard Deviations of Self-Reported Negative Mood

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1 pre eat	13.79 (3.86)	12.11 (4.08)	14.54 (4.40)	12.89 (2.90)
2 pre gift	13.90 (4.68)	13.40 (4.77)	14.30 (4.78)	13.90 (5.65)
3 post eat	12.66 (2.96)	11.97 (2.40)	12.69 (4.30)	12.45 (2.68)
4 post gift	14.90 (6.55)	13.73 (6.25)	15.43 (6.48)	13.67 (6.67)
5 control	15.73 (6.13)	15.47 (7.23)	15.53 (5.91)	14.27 (6.02)

Study 1 Males, Means and Standard Deviations of Self-Reported Negative Mood

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1 pre eat	16.16 (6.31)	15.29 (6.47)	16.29 (5.31)	13.86 (4.71)
2 pre gift	14.75 (5.44)	13.75 (6.54)	15.50 (6.12)	13.25 (4.95)
3 post eat	11.13 (1.36)	10.50 (1.07)	11.88 (1.73)	11.25 (1.83)
4 post gift	12.90 (2.47)	12.10 (2.18)	14.10 (3.63)	12.70 (3.56)
5 control	16.77 (6.27)	14.54 (4.20)	14.31 (4.33)	14.15 (4.88)

Study 1 Females, Means and Standard Deviations of Self-Reported Negative Mood

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1 pre eat	13.00 (2.51)	13.71 (3.04)	13.95 (4.03)	12.57 (2.06)
2 pre gift	13.67 (4.68)	13.29 (4.23)	13.90 (4.38)	14.19 (6.11)
3 post eat	13.24 (3.28)	12.52 (2.54)	13.00 (4.95)	12.90 (2.84)
4 post gift	15.90 (7.86)	14.55 (7.43)	16.10 (7.51)	14.15 (7.82)
5 control	14.94 (6.27)	16.18 (8.96)	16.37 (6.86)	14.35 (6.92)

Study 1, Means and Standard Deviations of Self-Reported Emotional Pain

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1 pre eat	2.57 (1.88)	2.50 (2.19)	3.39 (2.48)	2.86 (2.27)
2 pre gift	1.90 (2.23)	1.80 (2.33)	2.93 (2.57)	2.07 (2.27)
3 post eat	1.90 (2.17)	1.83 (2.16)	2.79 (2.11)	1.48 (1.96)
4 post gift	2.73 (2.14)	2.37 (2.33)	3.60 (2.54)	2.47 (2.22)
5 control	2.77 (2.60)	2.67 (2.56)	3.00 (2.39)	2.43 (2.61)

Table 7, continued

Study 1 Males, Means and Standard Deviations of Self-Reported Emotional Pain

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1 pre eat	4.14 (2.41)	4.14 (2.48)	4.29 (2.29)	3.86 (2.54)
2 pre gift	1.38 (2.07)	1.50 (2.33)	3.13 (3.09)	2.00 (3.12)
3 post eat	1.88 (2.59)	1.88 (2.59)	2.63 (2.39)	1.63 (2.20)
4 post gift	3.40 (2.63)	3.10 (2.56)	4.10 (2.81)	2.80 (2.57)
5 control	3.15 (2.54)	2.77 (2.31)	3.08 (2.02)	2.62 (2.40)

Study 1 Females, Means and Standard Deviations of Self-Reported Emotional Pain

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
1 pre eat	2.05 (1.43)	1.95 (1.83)	3.10 (2.53)	2.52 (2.11)
2 pre gift	2.14 (2.39)	1.95 (2.42)	2.86 (2.50)	2.05 (2.01)
3 post eat	1.90 (2.12)	1.81 (2.04)	2.86 (2.06)	1.43 (1.91)
4 post gift	2.40 (1.90)	2.00 (2.18)	3.35 (2.43)	2.30 (2.08)
5 control	2.47 (2.76)	2.59 (2.81)	2.94 (2.70)	2.29 (2.82)

Table 8

Study 1, Predicting Self-Reported Negative Moods at Time 4 with Perceived Social Support, controlling for Self-Reported Negative Moods at Time 1

Variable	Step 1				Step 2			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	2.57	0.77		.001	2.58	0.78		.001
NegMood	0.77	0.05	0.78	.000	0.77	0.05	0.78	.000
MSPSS					-0.06	0.28	-0.01	.829
R ²	0.61				0.61			
F for model	226.10***				112.33***			

Study 1, Predicting Self-Reported Emotional Pain at Time 4 with Perceived Social Support, controlling for Self-Reported Emotional Pain at Time 1

Variable	Step 1				Step 2			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	.20	0.14		.160	.17	0.15		.245
EmoPain	0.87	0.04	0.86	.000	0.88	0.05	0.87	.000
MSPSS					0.12	0.11	0.05	.284
R ²	0.73				0.74			
F for model	400.21***				200.90***			

Note. ****p* = .000.

NegMood = PANAS, negative mood subscale, at Time 1.

MSPSS = Multidimensional Scale of Perceived Social Support.

EmoPain = Emotional Pain Slide, at Time 1.

Table 9

Study 1, Predicting Self-Reported Negative Moods at Time 4 with Experimental Condition (1 & 3 v. 5) and Perceived Social Support, controlling for Self-Reported Negative Moods at Time 1

Variable	Step 1				Step 2				Step 3			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	4.06	0.98		.000	3.91	0.97		.000	3.81	0.93		.000
NegMood	0.65	0.07	0.73	.000	0.66	0.07	0.75	.000	0.67	0.07	0.75	.000
Conditions					-0.19	0.68	-0.02	.781	-0.54	0.65	-0.06	.415
MSPSS					0.71	0.41	0.13	.09	-0.05	0.46	-0.01	.921
Conditions x MSPSS									2.67	0.86	0.26	.003
R ²	0.54				0.55				0.60			
F for model	98.13***				34.13***				30.69***			

Note. ****p* = .000.

NegMood = PANAS, negative mood subscale, at Time 1.

Conditions = Experimental conditions 1 & 3 v. 5

MSPSS = Multidimensional Scale of Perceived Social Support.

Table 9, continued

Study 1, Predicting Self-Reported Emotional Pain at Time 4 with Experimental Condition (1 & 3 v. 5) and Perceived Social Support, controlling for Self-Reported Emotional Pain at Time 1

Variable	Step 1				Step 2				Step 3			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	0.12	0.18		.521	0.14	0.20		.480	0.14	0.20		.481
EmoPain	0.88	0.06	0.87	.000	0.91	0.06	0.89	.000	0.91	0.06	0.89	.000
Conditions					-0.27	0.27	-0.05	.316	-0.27	0.27	-0.06	.319
MSPSS					0.34	0.17	0.11	.047	0.33	0.20	0.11	.104
Conditions x MSPSS									0.03	0.37	0.01	.933
R ²	0.75				0.76				0.76			
F for model	254.72***				89.13***				66.05***			

Note. ****p* = .000.

EmoPain = Emotional Pain Slide, at Time 1.

Conditions = Experimental conditions 1 & 3 v. 5

MSPSS = Multidimensional Scale of Perceived Social Support.

Table 10

Study 2, Means and Standard Deviations of Self-Reported Negative Mood

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
6 pre eat	14.00 (2.91)	12.48 (2.59)	12.72 (3.32)	12.79 (2.65)
7 pre gift	14.90 (4.25)	13.14 (3.60)	12.48 (3.16)	13.07 (3.35)
8 control	13.83 (2.70)	12.43 (2.53)	12.20 (3.17)	12.40 (2.91)

Study 2 Males, Means and Standard Deviations of Self-Reported Negative Mood

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
6 pre eat	14.75 (2.87)	14.00 (4.08)	13.25 (3.40)	13.75 (3.77)
7 pre gift	11.50 (1.29)	12.00 (2.83)	12.50 (2.89)	13.50 (3.70)
8 control	13.25 (2.36)	12.75 (3.10)	11.75 (3.50)	12.00 (3.37)

Study 2 Females, Means and Standard Deviations of Self-Reported Negative Mood

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
6 pre eat	13.88 (3.02)	12.24 (2.30)	12.64 (3.37)	12.64 (2.50)
7 pre gift	15.44 (4.40)	13.32 (3.73)	12.48 (3.25)	13.00 (3.37)
8 control	13.92 (2.83)	12.38 (2.50)	12.27 (3.18)	12.46 (2.90)

Study 2, Means and Standard Deviations of Self-Reported Physical Pain

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
6 pre eat	0.79 (1.27)	1.28 (1.46)	0.86 (1.19)	1.72 (1.22)
7 pre gift	0.93 (1.55)	1.38 (1.66)	1.00 (1.63)	1.86 (1.57)
8 control	0.47 (0.85)	1.03 (0.85)	0.63 (0.93)	1.45 (1.04)

Study 2 Males, Means and Standard Deviations of Self-Reported Physical Pain

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
6 pre eat	0.75 (1.50)	1.50 (1.73)	1.25 (1.50)	2.00 (0.82)
7 pre gift	0.73 (0.00)	0.50 (0.58)	0.50 (1.00)	1.50 (1.00)
8 control	0.50 (1.00)	0.75 (0.96)	0.75 (0.96)	0.75 (0.96)

Study 2 Females, Means and Standard Deviations of Self-Reported Physical Pain

Condition	Time 1	Time 2	Time 3	Time 4
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
6 pre eat	0.80 (1.29)	1.24 (1.45)	0.80 (1.15)	1.68 (1.28)
7 pre gift	1.08 (1.66)	1.52 (1.73)	1.08 (1.71)	1.92 (1.66)
8 control	0.46 (0.86)	1.08 (0.84)	0.62 (0.94)	1.58 (1.03)

Table 10, continued

Study 2, Means and Standard Deviations of Average Pain Threshold Scores and Average Pain Tolerance Scores

Condition	Threshold	Tolerance
	Mean (SD)	Mean (SD)
6 pre eat	3.95 (1.28)	7.63 (3.18)
7 pre gift	4.05 (2.33)	8.04 (4.07)
8 control	3.72 (1.82)	8.76 (5.40)

Study 2 Males, Means and Standard Deviations of Average Pain Threshold Scores and Average Pain Tolerance Scores

Condition	Threshold	Tolerance
	Mean (SD)	Mean (SD)
6 pre eat	3.50 (2.09)	10.01 (5.42)
7 pre gift	4.93 (0.89)	8.62 (1.93)
8 control	4.23 (1.91)	11.56 (9.49)

Study 2 Females, Means and Standard Deviations of Average Pain Threshold Scores and Average Pain Tolerance Scores

Condition	Threshold	Tolerance
	Mean (SD)	Mean (SD)
6 pre eat	4.02 (1.15)	7.24 (2.65)
7 pre gift	3.91 (2.47)	7.94 (4.34)
8 control	3.65 (1.83)	8.33 (4.65)

Table 11

Study 2, Predicting Self-Reported Negative Moods at Time 4 with Perceived Social Support, controlling for Self-Reported Negative Moods at Time 1

Variable	Step 1				Step 2			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	5.33	1.10		.000	5.52	1.12		.000
NegMood	0.52	0.08	0.60	.000	0.51	0.08	0.58	.000
MSPSS					-0.27	0.29	-0.08	.344
R ²	0.35				0.35			
F for model	48.02***				24.43***			

Study 2, Predicting Self-Reported Physical Pain at Time 4 with Perceived Social Support, controlling for Self-Reported Physical Pain at Time 1

Variable	Step 1				Step 2			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	1.18	0.12		.000	1.18	0.12		.000
PhysPain	0.70	0.08	0.69	.000	0.70	0.08	0.69	.000
MSPSS					-0.08	0.11	-0.06	.457
R ²	0.47				0.48			
F for model	76.70***				38.43***			

Note. ****p* = .000.

NegMood = PANAS, negative mood subscale, at Time 1.

MSPSS = Multidimensional Scale of Perceived Social Support.

PhysPain = Physical Pain Slide, at Time 1.

Table 12

Study 2, Predicting Average Pain Threshold with Perceived Social Support, controlling for Baseline Pain Threshold

Variable	Step 1				Step 2			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	0.82	0.25		.002	0.82	0.26		.002
ThresholdB	0.79	0.06	0.82	.000	0.79	0.06	0.83	.000
MSPSS					-0.05	0.12	-0.03	.666
R ²	0.68				0.68			
F for model	182.47***				90.47***			

Study 2, Predicting Average Pain Tolerance with Perceived Social Support, controlling for Baseline Pain Tolerance

Variable	Step 1				Step 2			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	-0.26	0.48		.593	-0.25	0.48		.608
ToleranceB	0.99	0.05	0.90	.000	0.99	0.05	0.90	.000
MSPSS					0.14	0.22	0.03	.521
R ²	0.81				0.82			
F for model	375.37***				186.62***			

Note. ****p* = .000.

ThresholdB = Baseline Pain Threshold.

MSPSS = Multidimensional Scale of Perceived Social Support.

ToleranceB = Baseline Pain Tolerance.

Table 13

Study 2, Predicting Self-Reported Negative Moods at Time 4 with Experimental Condition (6 v. 8) and Perceived Social Support, controlling for Self-Reported Negative Moods at Time 1

Variable	Step 1				Step 2				Step 3			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	4.27	1.45		.005	5.08	1.49		.001	5.08	1.50		.001
NegMood	0.60	0.10	0.61	.000	0.55	0.10	0.56	.000	0.55	0.10	0.56	.000
Conditions					-.21	0.56	-0.04	.707	-0.24	0.57	-0.04	.672
MSPSS					-0.73	0.35	-0.22	.043	-0.96	0.45	-0.29	.037
Conditions x MSPSS									0.58	0.71	0.11	.413
R ²	0.37				0.42				0.43			
F for model	34.11***				13.41***				10.17***			

Note. ****p* = .000.

NegMood = PANAS, negative mood subscale at Time 1.

Conditions = Experimental conditions 6 v. 8.

MSPSS = Multidimensional Scale of Perceived Social Support.

Table 13, continued

Study 2, Predicting Self-Reported Physical Pain at Time 4 with Experimental Condition (6 v. 8) and Perceived Social Support, controlling for Self-Reported Physical Pain at Time 1

Variable	Step 1				Step 2				Step 3			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	1.21	0.14		.000	1.24	0.19		.000	1.25	.20		.000
PhysPain	0.62	0.11	0.60	.000	0.61	0.11	0.59	.000	0.60	0.11	0.58	.000
Conditions					-0.05	0.25	-0.02	.832	-0.04	0.25	-0.02	.868
MSPSS					-0.06	-.15	-0.04	.697	0.04	0.19	0.03	.830
Conditions x MSPSS									-0.26	0.30	-0.12	.400
R ²	0.36				0.36				0.37			
F for model	31.74***				10.32***				7.89***			

Note. ****p* = .000.

PhysPain = Physical Pain Slide at Time 1.

Conditions = Experimental conditions 6 v. 8.

MSPSS = Multidimensional Scale of Perceived Social Support.

Table 14

Study 2, Predicting Average Pain Threshold with Experimental Condition (6 v. 8) and Perceived Social Support, controlling for Baseline Pain Threshold

Variable	Step 1				Step 2				Step 3			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	0.88	0.28		.003	1.06	0.28		.000	1.04	0.28		.001
ThresholdB	0.76	0.07	0.84	.000	0.77	0.06	0.86	.000	0.78	0.06	0.86	.000
Conditions					-0.47	0.22	-0.15	.038	-0.45	0.22	-0.15	.043
MSPSS					-0.13	0.13	-0.07	.317	-0.01	0.17	-0.01	.947
Conditions x MSPSS									-0.32	0.27	-0.11	.247
R ²	0.70				0.72				0.72			
F for model	134.65***				49.90***				38.02***			

Note. ****p* = .000

ThresholdB = Baseline Pain Threshold.

Conditions = Experimental conditions 6 v. 8.

MSPSS = Multidimensional Scale of Perceived Social Support.

Table 14, continued

Study 2, Predicting Average Pain Tolerance with Experimental Condition (6 v. 8) and Perceived Social Support, controlling for Baseline Pain Tolerance

Variable	Step 1				Step 2				Step 3			
	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>	B	SE(B)	β	<i>p</i>
Intercept	-0.13	0.57		.823	-0.01	0.60		.990	-0.05	0.60		.936
ToleranceB	0.97	0.06	0.91	.000	0.98	0.06	0.91	.000	0.99	0.06	0.92	.000
Conditions					-0.39	0.51	-0.04	.448	-0.37	0.51	-0.04	.469
MSPSS					0.21	0.30	0.04	.487	0.42	0.39	0.08	0.29
Conditions x MSPSS									-0.53	0.63	-0.06	.399
R ²	0.82				0.82				0.82			
F for model	264.18***				86.85***				64.99***			

Note. ****p* = .000

ToleranceB = Baseline Pain Tolerance.

Conditions = Experimental conditions 6 v. 8.

MSPSS = Multidimensional Scale of Perceived Social Support.

Study 1 Methods

Between Subjects, Five Conditions:

1. Pre-pain Comfort Food
2. Pre-pain Gift Control
3. Post-pain Comfort Food
4. Post-pain Gift Control
5. Nothing

Self-Reported Mood & Pain Measured 4 Times:

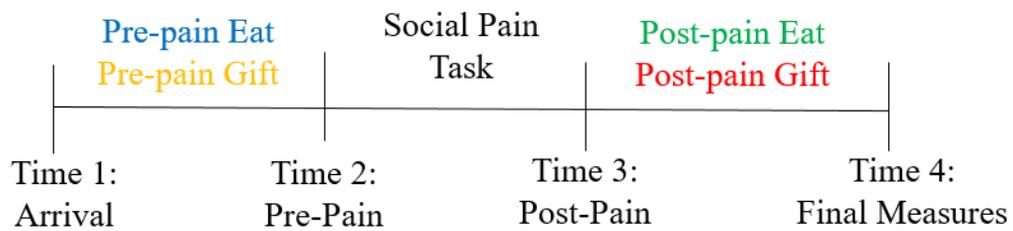


Figure 1. Study 1 Timeline

Study 2 Methods

Between Subjects, Three Conditions:

1. Pre-pain Comfort Food
2. Pre-pain Gift Control
3. Nothing

Self-Reported Mood & Pain Measured 4 Times:

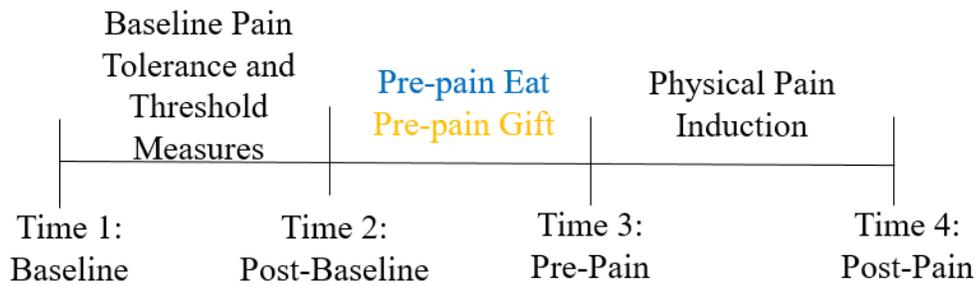


Figure 2. Study 2 Timeline

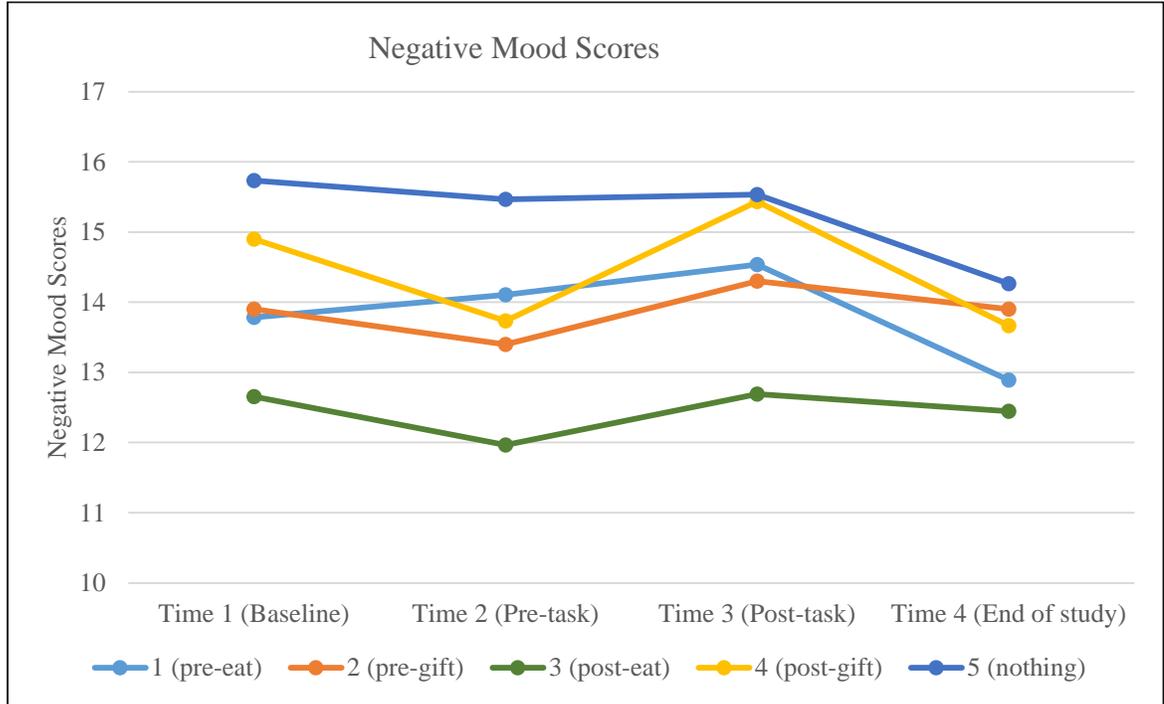


Figure 3. Study 1, Negative mood scores at Time 4

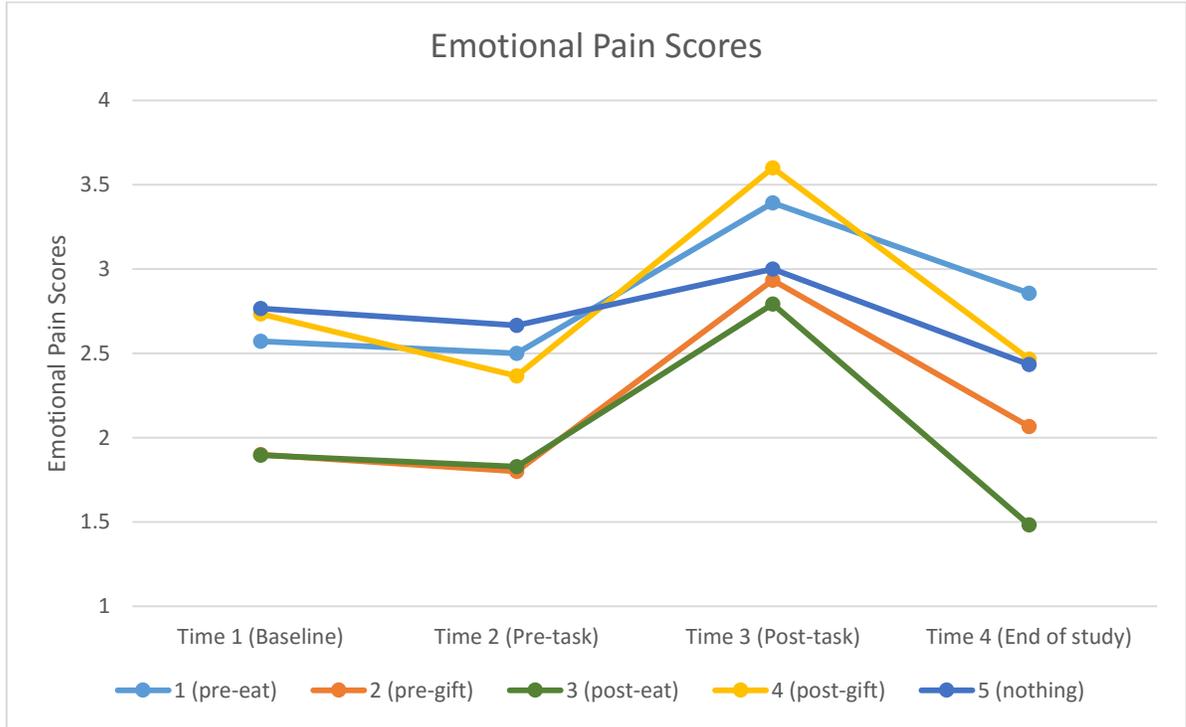


Figure 4. Study 1, Emotional pain scores at Time 4

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Appendix A

Study 1 Protocol

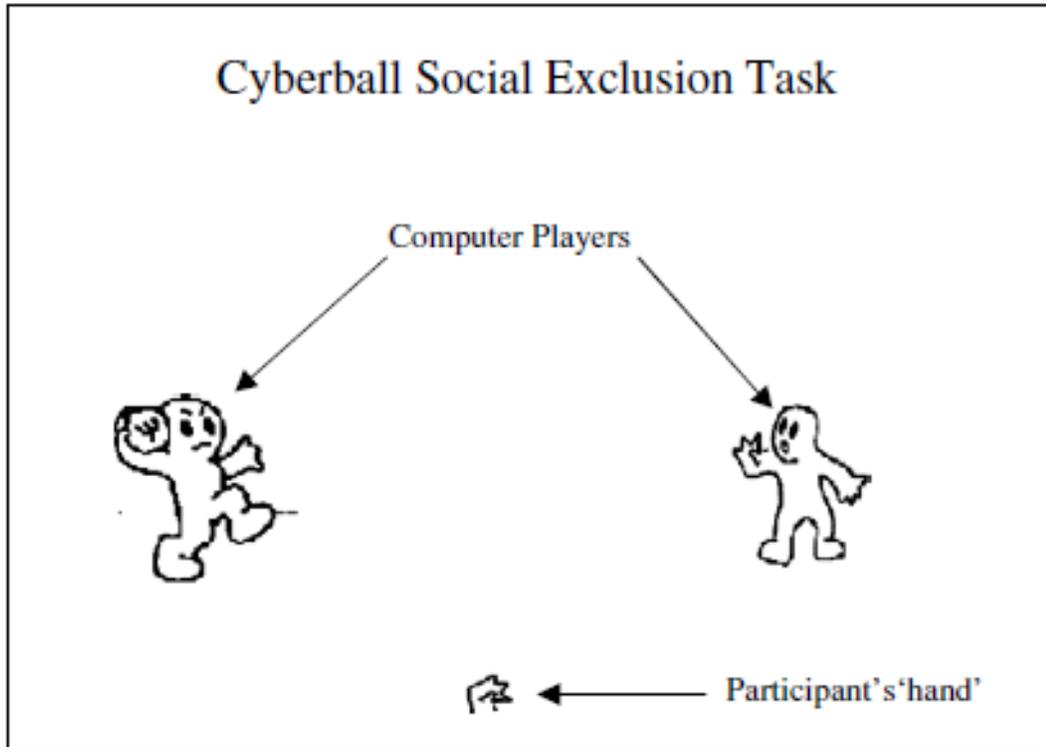
- 1) Participants responded to fliers for a study reportedly investigating “the effects of glucose on everyday tasks.”
- 2) Before arriving for the study, participants completed an online survey to assess: demographics, perceived social support, and comfort food preferences (~15 minutes)
- 3) Participants who indicated chocolate bars or potato chips as a comfort food were invited for the lab session and were randomly assigned to one of the five conditions.
- 4) Once at the lab, participants learned the supposed purpose of the study: learning how glucose affects day-to-day interactions because of the increase in snacking over the last ten years.
- 5) Research assistants explained the study procedure and answered participants’ questions.
- 6) Participants read and signed the consent form. (Steps 4-6: ~5 minutes)
- 7) Participants completed Time 1 measures: self-reported mood and emotional pain. (1 minute)
- 8) Research assistants provided participants with their chocolate bar or small bag of potato chips to eat (1), their comfort food gift to eat after the study (2), or nothing (3, 4, & 5). Participants ate their food or sat quietly for 3 minutes. (3:30 minutes)
- 9) After 3 minutes, research assistants returned to tell participants to continue with the computer portion of the study. Participants self-reported their mood and emotional pain. (1 minute)
- 10) Research assistants returned to set-up the social pain task. Participants played Cyberball. (4 minutes)
- 11) After the game, participants self-reported mood, emotional pain, and social distress. (1:30 minutes)
- 12) Research assistants provided participants with their comfort food to eat (3), their gift of comfort food to eat after the study (4), or nothing (1, 2, & 5). Participants ate their food or sat quietly for 3 minutes. (3:30 minutes)
- 13) After 3 minutes, research assistants returned to tell participants to continue with the final measures. Participants completed measures of mood, emotional pain, and suspicion of the purpose of the study. (5 minutes)
- 14) Finally, research assistants debriefed the subjects and ensured that they were no longer distressed. (2 minutes)

Appendix B

Study 2 Protocol

- 1) Participants responded to fliers for a study reportedly investigating “the effects of glucose on everyday tasks.”
- 2) Before arriving for the study, participants completed an online survey to assess: demographics, perceived social support, and comfort food preferences (~15 minutes)
- 3) Participants who indicated chocolate bars or potato chips as a comfort food were invited for the lab session and were randomly assigned to one of the three conditions.
- 4) Once at the lab, participants learned the supposed purpose of the study: learning how glucose affects everyday tasks because of the increase in snacking over the last ten years.
- 5) Research assistants explained the study procedure and answered any of the participants’ questions.
- 6) Participants read and signed the consent form. (Steps 4-6: ~5 minutes)
- 7) Participants completed Time 1 measures: self-reported mood and physical pain. (3 minutes)
- 8) Research assistants returned to obtain baseline pain tolerance and pain threshold measures. (~3 minutes)
- 9) Research assistants provided participants with their chocolate bar or small bag of potato chips to eat (6), their comfort food gift to eat after the study (7), or nothing (8). Participants will ate their food or sat quietly for 3 minutes. (3:30 minutes)
- 10) After 3 minutes, research assistants returned to tell participants to continue with the computer portion of the study. Participants self-reported their mood and physical pain. (3 minutes)
- 11) Research assistants returned to measure participants’ pain tolerance and pain threshold. (~3 minutes)
- 12) After the physical pain induction, participants self-reported mood, physical pain, and suspicion of the purpose of the study (6 minutes)
- 13) Finally, research assistants debriefed the subjects and ensured that they are no longer distressed. (2 minutes)

Appendix C



Appendix D

Positive Affect and Negative Affect Schedule (PANAS)

Instructions: This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you are currently feeling each of these emotion words. Use the following scale to record your answers:

1
very slightly
or not at all

2
a little

3
moderately

4
quite a bit

5
extremely

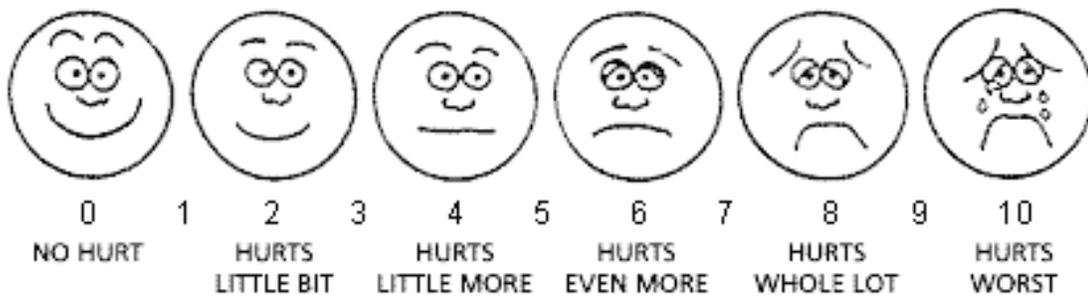
_____ interested
_____ distressed
_____ excited
_____ upset
_____ strong
_____ guilty
_____ scared
_____ hostile
_____ enthusiastic
_____ proud

_____ irritable
_____ alert
_____ ashamed
_____ inspired
_____ nervous
_____ determined
_____ attentive
_____ jittery
_____ active
_____ afraid

Appendix E

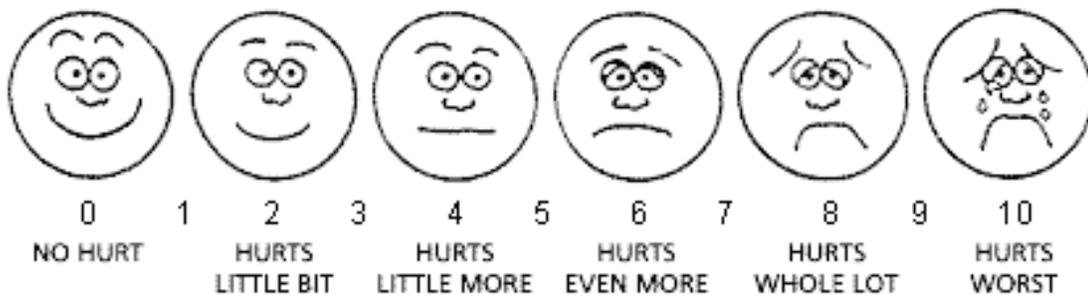
Pain Slide- Emotional Pain

Instructions: Please indicate on the scale below how much emotional pain (i.e., “It upsets me that my friend moved away for college.”) you are in.



Pain Slide- Physical Pain

Instructions: Please indicate on the scale below how much physical pain (i.e., “It hurts a lot that I sprained my ankle.”) you are in.



Appendix F

Need Threat Scale

Instructions: Please respond to each statement regarding how you felt after the online ball-toss game. Please respond on the following scale: *not at all* (1) to *extremely* (5).

1. "I felt liked."
2. "I felt rejected."
3. "I felt invisible."
4. "I felt I had control."
5. "I felt ignored."

Appendix G

Multidimensional Scale of Perceived Social Support

Instructions: We are interested in how you feel about the following statements. Read each statement carefully. Indicate how you feel about each statement.

Circle the "1" if you **Very Strongly Disagree**

Circle the "2" if you **Strongly Disagree**

Circle the "3" if you **Mildly Disagree**

Circle the "4" if you are **Neutral**

Circle the "5" if you **Mildly Agree**

Circle the "6" if you **Strongly Agree**

Circle the "7" if you **Very Strongly Agree**

1. There is a special person who is around when I am in need. 1 2 3 4 5 6 7
2. There is a special person with whom I can share my joys and sorrows. 1 2 3 4 5 6 7
3. My family really tries to help me. 1 2 3 4 5 6 7
4. I get the emotional help and support I need from my family. 1 2 3 4 5 6 7
5. I have a special person who is a real source of comfort to me. 1 2 3 4 5 6 7
6. My friends really try to help me. 1 2 3 4 5 6 7
7. I can count on my friends when things go wrong. 1 2 3 4 5 6 7
8. I can talk about my problems with my family. 1 2 3 4 5 6 7
9. I have friends with whom I can share my joys and sorrows. 1 2 3 4 5 6 7
10. There is a special person in my life who cares about my feelings. 1 2 3 4 5 6 7
11. My family is willing to help me make decisions. 1 2 3 4 5 6 7
12. I can talk about my problems with my friends. 1 2 3 4 5 6 7

Appendix H

Image of Excel spreadsheet to calculate the planned contrasts for self-reported emotional pain scores in Study 1. Portions of this spreadsheet are below to show in greater detail these analyses.

Planned Contrasts					
	Condition 1	Condition 2	Condition 3	Condition 4	Condition 5
Hypothesis 1	3	0	-1	-1	-1
Hypothesis 2	0	3	-1	-1	-1
Hypothesis 3	0	0	1	0	-1
Hypothesis 4	1	-1	0	0	0
Hypothesis 5	0	0	1	-1	0
Hypothesis 6	1	0	-1	0	0

Condition	N	Time 2 Q33 EmoPain2 Mean	SD	Time 3 Q27 EmoPain3 Mean	SD	Time 4 Q31 EmoPain4 Mean	SD	Time 5 EmoPain5 Mean	SD
1	28	2.5	2.18581	3.3929	2.48461	2.8571	2.25609	2.5714	2.5714
2	30	1.8	2.32527	2.9933	2.57218	2.0667	2.27328	2	1
3	29	3	3.8276	2.15587	2.7951	2.11084	1.4828	1.95709	3
4	30	4	2.9667	2.32651	4	3.6	2.5407	2.4667	2.2421
5	30	5	2.6667	2.56412	5	3	2.39252	2.4333	2.68088
Total N:	147								

Hypothesis	Contrast	t den	t value	p value
Hypothesis 1: Group 1 will experience less emotional pain at Time 3 compared to groups 3, 4, 5	0.7856	0.6977176	1.125957	0.130687
Hypothesis 2: Group 2 will experience less emotional pain at Time 3 compared to groups 3, 4, 5	-0.5932	0.6797971	-0.872613	0.191909
Hypothesis 3: Group 3 will experience less pain at Time 4 compared to group 5	-0.9505	0.279507	-3.43631	0.000399
Hypothesis 4: Supported! Group 3 experienced LESS emotional pain than group 5 at Time 4.				Cohen's d = -0.405

The planned contrasts and formulas used to calculate the differences between the conditions.

Planned Contrasts					
	Condition 1	Condition 2	Condition 3	Condition 4	Condition 5
Hypothesis 1	3	0	-1	-1	-1
Hypothesis 2	0	3	-1	-1	-1
Hypothesis 3	0	0	1	0	-1
Hypothesis 4	1	-1	0	0	0
Hypothesis 5	0	0	1	-1	0
Hypothesis 6	1	0	-1	0	0

$$\hat{C} = w_1\bar{X}_1 + w_2\bar{X}_2 + w_3\bar{X}_3 + w_4\bar{X}_4$$

$$\hat{C} = \sum_{i=1}^k w_i\bar{X}_i$$

$$t = \frac{\hat{C}}{\sqrt{MS_w \left[\sum_{i=1}^k \frac{w_i^2}{n_i} \right]}}$$

(Appendix H, cont.)

The necessary information from the ANCOVA, the sample sizes, and the means and standard deviations of self-reported emotional pain used to calculate the t-tests.

H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W
				Time 2	Q18 EmoPain2			Time 3	Q27 EmoPain3			Time 4	Q31 EmoPain4		
	MSerror	1.152			Mean	SD			Mean	SD			Mean	SD	
	df	223.524		1	2.5	2.18581		1	3.3929	2.48461		1	2.8571	2.25609	
	Sample Sizes			2	1.8	2.32527		2	2.9333	2.57218		2	2.0667	2.27328	
	Condition	N		3	1.8276	2.15587		3	2.7931	2.11084		3	1.4828	1.95705	
	1	28		4	2.3667	2.32651		4	3.6	2.5407		4	2.4667	2.22421	
	2	30		5	2.6667	2.56412		5	3	2.39252		5	2.4333	2.68088	
	3	29													
	4	30													
	5	30													
	Total N:	147													

Each hypothesis with corresponding t-test.

Hypothesis 1: Group 1 will experience less emotional pain at Time 3 compared to groups 3, 4, 5			
Contrast:	0.7856	t den:	0.6977176
t value:	1.125957		
p value:	0.130687		
Hypothesis 2: Group 2 will experience less emotional pain at Time 3 compared to groups 3, 4, 5			
Contrast:	-0.5932	t den:	0.6797971
t value:	-0.872613		
p value:	0.191909		
Hypothesis 3: Group 3 will experience less pain at Time 4 compared to group 5			
Contrast:	-0.9505	t den:	0.279507
t value:	-3.400631	Supported:	Group 3 experienced LESS emotional pain than group 5 at Time 4.
p value:	0.000399	Cohen's d	-0.405

Footnote

¹Due to the similarities between conditions in Study 1 and Study 2, I started the first condition in Study 2 as Condition 6 to enhance clarity when discussing methods and results of the two studies.