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Determining the Relationship of Moods and Expectations in Placebo Analgesia

by

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Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

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An Abstract of

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The present study aimed to test the relationship between mood states and expectations in placebo analgesia. Prior studies show that both mood states and expectations individually affect pain. However, no studies examine these two constructs in combination. A pilot study failed to create an effective expectation, so the research question could not be answered. The proposed study aimed to remedy the shortcomings of the pilot study and to answer this question. Mood induction caused either positive or neutral mood for participants. Independently of mood state, participants received a false expectation about pain relief (i.e. placebo analgesia) or no expectation about pain relief and took part in a laboratory pain task, the ischemic pain task. There were no significant effects for mood, expectation, or an interaction of mood and expectations on pain experience. The proposed study failed to create a greater expectation of pain relief. Reasons for these null effects and directions for future research are discussed.
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Chapter 1

Introduction

As Dennett (1991, p. 117) aptly states, “The fundamental purpose of brains is to produce future.” People go through every day of their lives trying to anticipate the future: “It’s Monday,” “TGIF,” “What will my wife do if I tell her how she really looks in those jeans,” “It’s snowing.” All these statements have one thing in common: an expectation is built into every one of them. Olson, Roese, and Zanna (1996) define expectations as beliefs about a future state of affairs. The first two example statements above revolve around work—the week is starting so people expect it to drag by because they have to work, but at the end they rejoice for what they expect will be a fun and entertaining weekend. Someone’s wife asks them how she looks in those jeans and they automatically answer that she looks great, because they know, they can expect, what will happen if they tell her anything differently. Even with seemingly simple assessments like those made when observing the weather, human brains are interpreting and estimating future affairs. If it’s snowing, people expect their drive to be slower, the temperature is cold outside, or they envision the fresh powder on the mountain and how great the skiing is going to be. Brains are hardwired to make constant and varied expectations about future life events (Olson et al., 1996).

Expectations

The expectations people make can be both conscious and nonconscious (Kirsch, 1999). Individuals tend to be familiar with conscious expectations—as these expectancies are driven by moment-to-moment thoughts in awareness. Nonconscious expectations can be less obvious. Think about when someone cooks on the stove.
Their hand automatically avoids the hot burners. Their brain expects pain if they touch
the red hot burner, so it automatically has them avoid it. This knowledge is engrained
so that people do not have to consciously think about trying to avoid that burner.
Sometimes however, the hand slips and touches that burner which results in a burn and
a nice sized blister. For the next hour or so while they are still cooking and the fingers
are throbbing, they become extremely careful around the burners knowing, expecting,
that if they touch it again another painful blister will appear. This expectation, which
was previously unconscious, has become painfully conscious. However, over time,
that expectation will move back to the unconscious.

Expectations clearly exist, but where do they come from? Olson et al.
(1996) give three major sources of where expectations originate. The first major
source of expectation is direct experience (Fazio & Zanna, 1981). With the
example of the hot burner, you may expect it to burn you if you touch it, because it
has burned you when you have touched it in the past. A second major source of
expectations is through indirect experience - information from others. For instance,
expectancies can from peer groups (Newcomb, 1943) or from institutions and mass
media (Kinder & Sears, 1985; Oskamp, 1991; Patterson, 1980; Schonbach, 1981).
An example of this would be a person’s mother telling them that the burner is hot
and will burn them. The third source of expectations comes from other expectations
and by the combination and extrapolation of one’s existing knowledge. Again with
the burner example, the expectation of it burning them flowed naturally from, “it’s
red hot”, to the belief that “it always burns when it’s red hot”, so “it will burn me.”
**Placebo Expectations**

Expectations can come from a variety of places and they are about a vast array of topics. As mentioned previously, individuals often develop expectations from the information provided by others, like medical practitioners explaining the likely effects of a disease, drug, or treatment. Importantly, individuals commonly perceive and judge experiences as being consistent with earlier expectations for that experience (Anderson & Pennebaker, 1980). That is, experiences are frequently assimilated to expectations.

Placebo effects are a phenomenon in the medically related literature where the expectation given by the medical practitioner is key. Placebo effects are physiological or psychological responses to inert substances or medical procedures (Ross & Olson, 1981, 1982). Though this is a good definition for placebo effects as normally explored by psychologists, it is a bit limited. Shapiro states, “Uncontrolled studies [i.e., those lacking placebo conditions] of drug efficacy are reported effective four to five times more frequently than controlled studies” (1971, p. 598). Furthermore, Kirsch and Sapirstein (1998) show that the benefit of antidepressant medications in clinical practice are largely due to placebo effects. The key difference between these statements and the definition by Ross and Olson is that placebo effects are occurring with and enhancing the efficacy of a pharmacologically active drug. A better definition of placebo effects would be physiological or psychological responses to substances or treatments beyond what can be accounted for by a substance or treatment alone (Rose, Geers, Rasinski, & Fowler, 2011).
Placebo effects are important to study in a medical field because they have the potential to be very powerful. Some medical scholars have argued that the phenomenon should be strategically incorporated into routine medical practice (Chaput de Saintonge & Herxheimer, 1994). Placebo effects can be given to either increase the efficacy of a current treatment option or be given as a supplemental treatment to better a patient’s well-being. However, before the placebo effect could be utilized in medical care, it is important for researchers to provide a more complete understanding of the phenomenon.

Placebo effects have been documented in a variety of different scenarios, from treatment types, individuals, or domains (for reviews see Benedetti, 2008; Rief, Hofmann, & Nestoriuc, 2008; Stewart-Williams & Podd, 2004). Placebo effects are commonly observed in the domain of pain relief, i.e. placebo analgesia (for reviews see Harrington, 1999; Kirsch, 1999; Price et al., 2008). Placebo analgesia is a particularly important topic for investigation. First, pain is the most common health complaint reported to physicians—making it a leading contributor to health care costs in the United States (Institute of Medicine of the National Academies, 2011; National Centers for Health Statistics, 2006). Second, there is substantial evidence that both pharmacological and non-pharmacological treatments for pain benefit greatly from placebo analgesic effects (Atlas, Wager, Dahl, & Smith, 2009; Levine, Gordon, & Fields, 1978).

Most research concerning placebo analgesia has revolved around discovering the neurophysiological mechanisms that underlie placebo responses in pain relief contexts (see Geers & Rose, 2011). This work began with a 1978 landmark study in
which Levine et al. (1978) demonstrated that placebo analgesia can be blocked by the administration of the opioid antagonist naloxone. This work, directly implicating endogenous opioids in placebo analgesia, was key in elevating the placebo effect from the status of a merely false positive signal of treatment efficacy, to that of a psychobiological phenomenon of potential clinical significance linked to detectable changes in the brain. Since this pioneering work, there has been an explosion of scientific research illuminating the complex neurophysiological mechanisms involved in placebo analgesia.

Notably, relatively little research has been conducted to look at the social psychological factors involved in placebo effects and when these effects are strongest (Hyland, 2011; Price & Fields, 1997). Nonetheless, such research would be extremely valuable as placebo effects are to a large extent driven by a patient’s subjective interpretation of the clinical encounter and the interpersonal context surrounding treatment. Recently, researchers have begun to fill this gap. For example, in one study examining a social-cognitive variable moderating placebo analgesia, Rose et al. (2011) found that when people are given choice over their (placebo) treatment it increases the power of the analgesic expectation. In this study, participants came into the lab to participate in the cold pressor task, where they immersed their hand in ice water set at 8 degrees Celsius for 75s. Participants were assigned to one of three groups, choice, no choice, or control. They were given an expectation about a hand cream. Participants in the control condition were told that the hand cream was simply a cleaning agent. Participants in the no-choice condition were told that the cream was a topical anesthetic that would reduce the pain caused by the cold water. Finally, the participants in the
choice condition were given the same expectation as the participants in the no choice condition, but were given this expectation about two different hand creams and were allowed to choose which one they preferred to use. In reality, the actual cream was hand lotion mixed with oil of thyme to give it a medicinal smell, so there was no medicinal effect of the cream. The results revealed that participants who were given choice over the pain relief cream actually felt less pain than the participants in the other conditions. Brown, Fowler, Rasinski, Rose and Geers (2013) replicated and extended these findings to a new paradigm using aversive auditory stimuli.

Another moderator of the strength of placebo effects, and more specifically placebo analgesia, is the belief in expectation bias (Handley, Fowler, Rasinski, Helfer, & Geers, 2013). In a recent study demonstrating this moderating effect, the authors predicted that the extent to which people believe that expectations bias, or influence, their experiences colors their subsequent experiences. The authors measured participants’ beliefs in expectation bias and then had them perform a cold pressor task for 2 minutes. Participants who had a low belief in expectation bias showed a standard placebo response such that when given an expectation to experience less pain during the task, they actually reported experiencing less pain. However, participants who had a high belief in expectation bias (over)corrected against the expectation that they would experience less pain due to the treatment and actually reported more pain.

Some personality factors have also been shown to affect placebo response. For example, Geers, Helfer, Kosbab, Weiland, and Landry (2005) showed that pessimists tended to display a placebo response when given a negative expectation; that is, they
felt more unpleasant when they were given an expectation that they would feel unpleasant after the treatment. Optimists did not show this trend. A follow-up study by the Geers group showed that optimists experienced better sleep quality in a sleep paradigm when given an expectation about a treatment designed to increase sleep quality (Geers, Kosbab, Helfer, Weiland, & Wellman, 2007). In this study, pessimists did not show the improved sleep quality. So, positive placebo effects are more pronounced for optimists, and negative placebo effects are more pronounced for pessimists.

These moderator studies display relatively straightforward ways to influence the magnitude of placebo analgesia. For example, simply giving a patient choice over their treatment can increase its efficacy. And, by having a patient fill out a questionnaire asking about their belief in expectation bias or how optimistic/pessimistic they are can help to understand how best to present information about treatments to patients. However, sometimes the treatment options are cut and dry, with no choice allowed in the treatment. Medical professionals and institutions are often very busy and handing out a questionnaire is not feasible because the amount of extra work that it creates will put an even greater strain on the medical personnel and could ultimately be a detriment to the treatment and outcome for the patient. Therefore, it is useful to identify more basic and easily malleable constructs. Affective states potentially affect placebo response, because affective states have been shown to increase pain tolerance (Sternbach, 1974) and to be affected by varying expectations (Forgas & Moylan, 1987).
Affective States

The term affect commonly combines two different states, emotional and mood (Schwarz & Clore, 2007). Schwarz and Clore (2007) give an excellent example of how common speech correctly refers to emotions and mood; a person says that they are “in” a good mood, but are angry “about” something. More specifically, moods are typically long-term, low intensity, and do not have a clear referent (Morris, 1989), whereas emotions arise from a specific situation, have a short duration, and are of high intensity (Ortony, Clore, & Collins, 1988).

Affect, and affective states, are catchall terms that can refer to either or both emotions and mood. Even though affect, affective states, mood states, and emotions are all words with slightly different meanings, they are most commonly used interchangeably in research – because of this these terms will be used interchangeably throughout this paper.

Affective States and Pain

Because pain relief is the primary focus of many placebo studies, the goal here is to show the effect of varying mood states on pain and ultimately how mood states can help in a placebo context. Mood, especially dysphoric states, influences pain tolerance and pain perception. Sternbach (1974) reviewed research examining the occurrence of pain during depression and how antidepressants reduce that pain. Some researchers theorize that the positive effects of antidepressant medications are due to the elevation of depressive moods of patients (e.g. Bryson & Wide, 1996). However, antidepressant medications reduce pain severity and distress even in patients not suffering from depression (Harrison, Glover, Feinmann, Pearce, & Harris, 1997). This is consistent
with the idea that the reduction of depression symptoms may not be the cause of the effectiveness of antidepressant medications in chronic pain treatment. An increase in positive mood may account for some of the effectiveness of antidepressants on chronic pain, rather than the reduction of depressive symptoms. Zelman, Howland, Nichols, and Cleeland (1991) used the Velten procedure (Velten, 1968), where participants are told to read a statement and try to experience the mood suggested by the statement, to induce euphoric, neutral, or depressive states in participants. After the mood induction, participants engaged in the cold pressor task. Zelman et al. found that tolerance, the length of time participants were willing to stay exposed to the cold water pain stimulus, increased when they were in a euphoric state when compared to the neutral mood state. Furthermore, participants’ pain tolerance decreased when they were in depressive states compared to neutral mood states. However, this pattern of finding was not found on ratings of pain. Interestingly, Berntzen and Sen (1986) used the Velten procedure but found that both positive and depressive moods led to increased pain ratings and that the depressive mood induction, but not the positive, led to an increase in pain tolerance during a cold pressor task. Although the findings are not consistent, the results do show a general pattern that mood states do affect pain ratings and tolerance.

Weisenberg, Raz, and Hener (1998) used film-induced mood to investigate pain perception. They used film, rather than the Velten procedure, to induce mood because a review of mood induction procedures rated film as the primary method of choice (Gerrards-Hesse, Spies, & Hesse, 1994). In this experiment participants were randomly assigned to one of ten conditions in a 3 (film type: uplifting, sad, neutral) x 3 (film length: 15 min, 30 min, 45 min) plus 1 (control/no film) design. Participants
went through the cold pressor task at 3 points: (1) baseline, (2) immediately after the film was over, and (3) after a 30 minute waiting period. They found that participants who watched the humorous film had increased pain tolerance and those participants who watched the longer films, regardless of type, showed increase pain tolerance after the 30-min wait period. The reduced pain in the longer film condition could be confounded by the length of time between immersions in the baseline screening and the final screening. The important finding for this study is that participants who watched humorous films had a higher pain tolerance.

**Affective States and Placebo Analgesia**

As described thus far, research shows that both mood and placebo expectations affect pain reports. However, as of yet, there has been no research examining how these two variables combine to influence pain. For example, it may be that mood states and placebo expectations have entirely independent effects on pain relief. Further, it is also possible that moods and placebo expectations combine in a multiplicative form to alter pain relief. The goal of the present work is to clarify how these two variables, when considered simultaneously, affect pain relief. Specifically, for the current research, the interest is how people react when they are in a positive, versus neutral mood, and are given a positive, pain-relieving, versus neutral expectation.

The separate literatures on mood and expectations reveal that both variables have independent pain reducing effects. Based on these distinct lines of work, one may hypothesize that when studied in combination there will be two main effects without any interaction between the two variables: One main effect of mood and one main effect of expectation with no additive effect by combining positive mood and positive
expectation. That said, in considering the possible ways in which mood and placebo expectations could relate in determining pain relief, there are three different mood theories that could play a role: 1) the mood congruency theory, 2) hedonic contingency model, or 3) the mood-as-resource hypothesis.

Mood congruency one of many mood theories that looks at how mood states alter the way people interpret events. Mood congruency is simply that people view objects and events congruently with their mood (Ziegler, 2010). Bower (1981, p. 139) states, “mood affects the way people elaborate or draw inferences from interpersonal events and that their expectations and predictions are positive or negative depending on their mood.” Thus, in situations such as when medical practitioners present information regarding a drug or treatment option to a patient, the patients’ moods should color the way they interpret the information given to them. Specifically, based on the principle of mood congruency, if the patient is in a positive mood s/he will think about the information in a more positive light and think about similar instances where a medical treatment worked; if the patient is in a negative mood then s/he will think about the information in a more negative light and think about similar instances where a medical treatment did not work. Critical for the present purposes, prior work suggests that positive mood states lead to more positive expectations than negative moods (Forgas & Moylan, 1987; Johnson & Tversky, 1983; Mayer, Gaschke, Braverman, & Evans, 1992). Based on the principle of mood congruency, one may predict that mood states and placebo expectations will interact to determine pain relief. Specifically, it could be predicted that pain relief will be greatest when a positive mood state and an analgesic expectation co-occur. That is, when participants are in a positive mood and
given a positive treatment expectation, they remember past instances when treatments have worked and thus believe in the efficacy of the treatment more.

A different theory on mood, the hedonic contingency model, argues that people try to achieve or maintain positive affective states by managing their moods (Wegener & Petty, 1994; Wegener, Petty, & Smith, 1995). According to this theory, people process information differently depending on what the information is and what mood state they are in. For example, a person in a positive mood state would readily process positive information which leads to greater persuasion for strong arguments. However, if someone in a positive mood encounters negative information, then the person will not be motivated to process the information and will not be more persuaded. Notably, in the present instance, the hedonic contingency model could lead to the same hypothesized effect of positive mood on placebo effects. That is, based on this model, one could predict that once a participant is put into a positive mood state s/he will be more persuaded by a positive, pain-relief, expectation which, would, in turn, increase the efficacy of the placebo treatment.

A third mood theory that could lead to an interaction between moods and expectation is the mood-as-resource hypothesis. According to the mood-as-resource hypothesis, a person’s positive mood is used as a resource to overcome short-term negative events or consequences (Das, Vonkeman, & Hartmann, 2012; Raghunathan & Trope, 2002). When people are in a positive mood they can use that as a resource to overcome a negative event like the cold pressor and focus more readily on the positive information about the pain relief. Furthermore, the positive mood can serve as a buffer for them while they are going through a pain task.
Study Hypotheses

The present studies have three major hypotheses. $H_1$ is that participants who receive both the positive mood induction and the positive, pain relieving, expectation will experience the least amount of pain. $H_2$ is that participants who receive neither the positive mood induction nor the positive expectation will experience the most amount of pain. And finally, $H_3$ is that participants who receive either the positive mood induction or the positive expectation will experience less pain than participants in $H_2$ but more than participants in $H_1$.

The primary hypothesis for this current work is that participants who are both in a positive mood and receive a pain relieving expectation experience the least amount of pain. There are a couple of different ways this could occur, either through two main effects of expectation and mood ($H_{1a}$) or through an interaction between expectation and mood ($H_{1b}$). The rationale behind $H_{1a}$ lies with the independent research showing that both mood (e.g. Weisenberg, Raz, and Hener, 1998) and expectancies (for reviews see Harrington, 1999; Kirsch, 1999; Price et al., 2008) affect pain experience. The rationale behind $H_{1b}$ lies with the various mood theories covered earlier (mood congruency, hedonic contingency, and mood-as-resource) that show interactions between mood and expectances. Furthermore, work by Desteno, Petty, Rucker, Wegener, and Braverman (2004) show that mood and expectancies do interact on judgments. However, since there is little to no research on mood and expectancies in a pain context the prediction is simply that the combination of both variables will be the most beneficial.

The second hypothesis is that participants who receive neither the positive
mood induction nor the pain relieving expectation will experience the greatest amounts of pain. This is due to the fact that participants who receive neither of these benefits have nothing added compared to the rest of the participants to help mitigate the pain from the task.

The third, and final, hypothesis is that people in either a positive mood or those who receive a pain relieving expectation will experience pain less than people who did not receive either, but greater than people who received both the positive mood and positive expectation. As with $H_{1a}$ the independent research on the pain relieving benefits of both moods and expectations suggest that participants will receive benefits from the positive mood or the expectation, but since they do not receive both they will not get the total combined benefit.
Chapter 2

Pilot Study

The Pilot Study was conducted to provide a preliminary test of the effects of mood and expectation on pain perception in a placebo paradigm. Specifically, it examined whether or not mood (positive versus neutral) would interact with a placebo expectation (analgesic versus none) in accounting for subsequent pain relief. Based on the mood congruency, hedonic contingency, and mood-as-resource theories, the predicted results were that individuals placed in a positive mood and given an analgesic expectation would experience the least amount of pain, individuals in a neutral mood and given no expectation would experience the most amount of pain, and individuals that were placed in a positive mood or given an analgesic expectation would experience intermediate amounts of pain.

Procedure

Eight-seven introductory psychology students (58 female) participated in exchange for partial course credit ($M$ age = 19.36; $SD$ = 1.81). Participants were run individually and randomly assigned to condition. Upon coming to the study they were greeted by an experimenter and seated at a computer station. The experimenter gave the participant an informed consent document to read and sign. After the participant completed the informed consent the experimenter collected it and had the participant begin a pre-questionnaire. The pre-questionnaire contained personal and family medical health history questions to promote the cover story of the experiment as medically related and so as to screen for Raynaud’s disease (see Appendix A). Raynaud’s disease is a disorder in which cold and stress triggers a hyper- activation
of the sympathetic nervous system which can lead to the narrowing of blood vessels, and in severe cases, tissue death. As participants with Raynaud’s disease could react adversely to the pain task used, they were not allowed to participants in the Pilot Study.

Mood manipulation. After the participants finished the pre-questionnaire, the experimenter left the room while the participant watched one of two videos, as part of a “product evaluations” task, each consisting of three clips taken from separate movies with a total time of approximately 12-15 minutes. Prior research (e.g., Halberstadt & Niedenthal, 1997; Handley, Lassiter, Nickell, & Herchenroeder, 2004; Niedenthal, Halberstadt, & Innes-Ker, 1999) has shown that these videos successfully induce either a happy (e.g., “City Slickers 2,” Crystal & Weiland, 1994) or neutral mood (e.g., a history of golf documentary). After the videos concluded, the participants answered some filler questions with the mood-manipulation check item embedded. The mood manipulation check (“How happy did the video make you feel?”) was scored on a 1-7 scale, with 1 = not at all and 7 = very happy.

Expectation manipulation. Next, the experimenter came back into the room and delivered the expectation manipulation. Participants in the expectation condition were told,

In this study, we are studying the properties of a new pain-reducer called “Trivaricane”. Trivaricane is a topical, local anesthetic that has been proven to be effective in studies at other universities. The drug is safe and, in essence, temporarily deadens the pain receptors in your skin and reduces sensitivity to a pain stimulus.
In contrast, participants in the control condition were told that the cream was an organic hand cleanser that is routinely applied to participants’ hands prior to beginning the upcoming cold water task. Participants next took part in a cold pressor task. The cold pressor is a standard laboratory procedure used to safely evoke pain through cold water immersion. In this task, participants submerge their hand, up to their wrist, into a container of water and crushed ice. In the present version of the task, the water temperature was set to 4 degrees Celsius and a circulating pump was placed in the bottom on the container of water to prevent a pocket of warm water from forming around the participant’s hand. Participants were asked to keep their hand in the water for a 2 minute period. Participants rated their pain when they first put their hand in the ice water and then every twenty seconds afterward until the end of the 2 minute period— for a total of 7 pain ratings. Participants rated their pain using the Wong-Baker Pain FACES scale (2001) which is an 11-point scale ranging from 0, no pain, to 10, worst pain imaginable (Figure 1), that was shown and described to them prior to the start of the task and left in front of them throughout the task. Participants were asked to keep their hands in the ice water until the time was complete, but told that if the pain became unbearable to notify the experimenter and that they could remove their hand. When the 2 minute period was over the experimenter notified the participants to remove their hand from the ice water and participants were instructed to dry off their hand with a towel that had been placed on the desk in front of them. Participants then completed a post-questionnaire on the computer. Embedded in the post-questionnaire was the following expectation manipulation check item, “When the cream was put on your hand
did you expect it to protect you from the ice water?” Responses to this item were made on a 1-7 scale, with anchors points of 1 = not at all and 7 = very much. After the post-questionnaire was completed the participants were debriefed, thanked for their participation, and dismissed.

**Results**

**Study exclusions.** Based on prior research (e.g., Geers et al., 2013, Handley et al., 2013; Rose et al., 2012), participants were removed from the study if they expressed understanding of the purpose of the study (N = 1), if the initial temperature of the water was ± 0.6 degrees Celsius off the target temperature of 4 degrees Celsius (N = 2), or if they reported being in pain prior to starting the study (N = 5). After these exclusions, 72 participants remained. The pattern of the data remained the same with these participants included.

**Manipulation checks data.** Two Independent Sample t-tests were conducted to assess the effectiveness of the mood and the expectation manipulations. The first test indicated that participants who watched the happy video clips reported feeling happier ($M = 4.63$, $SD = 1.48$) than participants who watched the neutral video clips ($M = 3.23$, $SD = 1.44$), $t(70) = 4.05$, $p < .0005$, Cohen’s $d = .97$. Participants who received the expectation manipulation expected the hand cream to protect them from the water ($M = 3.97$, $SD = 2.18$) more than participants who did not receive the expectation manipulation ($M = 1.55$, $SD = 1.06$, $t(70) = 6.09$, $p < .0005$, Cohen’s $d = 1.72$.

**Pain ratings.** To examine how the two manipulations alter pain reports, a repeated measures analysis of variance (ANOVA) was conducted to compare the
initial and final pain rating provided by participants. The results of this ANOVA showed that there was a significant main effect of time $F(1,65) = 396.3$, $p < .0005$, $\eta^2 = .859$, observed power = 1.0, such that people felt more pain at the final pain rating than the initial pain rating. There was a significant interaction between time and mood on pain ratings $F(1, 65) = 9.23$, $p < .005$ ($M_{diff} = 1.86$, $SD_{diff} = 5.06$), $\eta^2 = .124$, observed power = .849, but there was not a significant interaction between time and expectation on pain ratings $F(1, 65) = 0.15$, $p > .7$ ($M_{diff} = -.26$, $SD_{diff} = 5.36$), $\eta^2 = .002$, observed power = .066, or an interaction between time, mood, and expectation on pain ratings $F(1, 65) = 0.15$, $p > .6$, $\eta^2 = .002$, observed power = .067. Figure 2 shows the graphical representation of the pain ratings over time as a function of condition. This visual representation supports the results of the ANOVA that there is no difference between groups receiving different expectations, but that the groups receiving the positive mood manipulation have lower pain ratings than the groups receiving the neutral mood manipulation. Because the effect of mood is similar regardless of the expectation condition, Figure 3 collapses across the expectation conditions and just shows how participants in the positive and neutral mood conditions differ across time. Post-hoc analyses revealed that participants who watched the happy video clips reported significantly less pain at times 80s $t(70) = 2.31$, $p < .025$, Cohen’s $d = .55$; 100s $t(70) = 2.72$, $p < .009$, Cohen’s $d = .65$; and 120s $t(70) = 2.75$, $p < .008$, Cohen’s $d = .66$, as compared to those watching the neutral video clips. There were no significant differences between mood conditions for the online pain ratings at times 0s, 20s, 40s, and 60s, all $ps > .09$, all Cohen’s $d < .41$. 

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Discussion

The primary purpose of the Pilot Study was to experimentally test the simultaneous effects of a placebo expectation and a positive mood on pain perception. The results did show that pain increases more slowly when participants are in a happy, compared to neutral, mood. Prior studies looking at mood and pain have similarly shown that participants in a happier mood are able to endure pain tasks like the cold pressor for longer than participants in a neutral mood. The present study did not use an endurance measure of pain but rather examined participants’ pain experience. The results show that actual pain ratings are lower as time goes on for participants in a happier mood as compared to participants in a neutral mood. These pain-experience findings may help to explain the endurance of the participants in the other studies. That is, because participants in the happy mood condition experience less pain than participants in the neutral mood condition they can keep their hand in the water longer. The participants in the neutral-mood condition may want to remove their hand sooner due to feeling higher levels of pain earlier in the task.

Although the present results do add a novel finding to the literature (i.e., positive moods reduce on-line pain reports during the cold-pressor task), they do not allow us to determine if a positive mood state enhances the pain relief experienced from a positive placebo expectation. Unfortunately, there was not an effect of the expectation manipulation on pain in the Pilot Study—nor was there an interaction between expectation and mood. As a consequence, the conditions needed to ascertain the ability of mood states to alter placebo expectation effects were not realized. A couple potential explanations for the null effect found for the expectation manipulation
is that the expectation was not strong enough to alter pain reports and that the cold pressor task was too strong of a pain task. For this reason, the goal of the main experiment, to be described next, is to enhance the expectation for pain relief and reduce the pain experienced during the pain task so as to provide the necessary conditions to test the current hypotheses.

Thus, the aim of the proposed study is to provide a stronger expectation and a weaker pain stimulus, which, in combination with the already strong mood manipulation, should allow us to answer the primary research question under consideration.
Chapter 3
Main Study

The proposed study will attempt to answer the same question as the Pilot Study, namely, what are the simultaneous effects of mood and placebo expectation on placebo analgesia. Because the Pilot Study did not effectively answer that question, the experimental design was changed in several key ways to better answer that question. The primary shortcomings of the prior study are theorized to be (1) the weakness of the expectation manipulation, (2) the intensity of the pain task, and (3) the context surrounding the task (e.g., the experiment room) which did little to support the cover story provided to participants. Each of these points will be address in turn.

The expectation manipulation was the crux of the prior experiment. Even though the results showed a significant finding for the expectation manipulation check, the expectation had no effect on the pain ratings. The expectation needs to have an effect on pain reports to see if the mood and expectations combine in two main effects or interact. A potential problem with the expectation in the Pilot Study was that it was too weak to overcome the high level of pain generated by the cold pressor task. So, to remedy this issue in the main experiment attempted to strengthen the expectation manipulation. In the prior study expectation participants were simply told that a cream was going to have an effect and put it on their hand. In the current experiment the expectation participants were informed that breathing in oxygen through an oxygen mask will help reduce their pain. With the oxygen mask being on their face, the expectation will be much more salient to the participants, which should make it a stronger manipulation – it should be noted that this is a new expectation manipulation
that has not been used before. Benedetti et al. (2003) showed that patients who were
given open (salient) injections of medicine (e.g., morphine) reported lower pain
intensity compared to patients who were given hidden (non-salient) treatment. This
study gives evidence that the more salient a treatment is, the more effective it will be.

The next potential shortcoming of the Pilot Study was the selection of the pain
task employed. Although the cold pressor task is a commonly used procedure, it is
also a very painful procedure (Rainville, Feine, Bushnell, & Duncan, 1992). Rainville
et al. (1992) compared four different pain paradigms (contact heat, electric shock,
ischemic pain, and cold pressor pain). In their study, cold pressor pain had the
highest levels of pain, with pain ratings from ischemic pain close in magnitude.
However, other studies comparing cold pressor pain to ischemic pain (Manning &
Fillingim, 2002; Rahim-Williams et al, 2007; Ring et al., 2007) show a consistent
pattern of ischemic pain being less painful than cold pressor pain. Three important
points should be noted about these studies (Manning & Fillingim, 2002; Rahim-
Williams et al., 2007; Rainville et al., 1992; Ring et al., 2007): 1) the studies
consistently show that pain reports at 5 minutes for the ischemic pain task are lower
than pain reports at 2 minutes for the cold pressor task, 2) the ischemic pain task starts
off at a much lower level of pain than the cold pressor task, and 3) that the ischemic
pain task shows a linear trend in pain ratings compared to the parabolic nature of the
cold pressor pain ratings. The first point, the overall pain with the ischemic pain task
after 5 minutes is lower than the cold pressor is after only 2 minutes, is important in
confirming that this is a less painful task than the 2 minute cold pressor pain task used
in the Pilot Study. The second point that the ischemic pain starts off at a much lower
level of pain is important because of the findings, shown in Figure 3, that when a participant is in a positive mood they experience a slightly higher pain at the beginning of the task ($M = 2.08, SD = 2.82$) compared to when a participant is in a neutral mood ($M = 1.49, SD = 1.43$). This is thought to occur because of the initial pain explicitly contradicts the mood that the participant is in, and by reducing that initial pain, the two mood groups will react more similarly at the beginning of the study. The final point, that the ischemic pain task shows a linear trend in pain ratings is important because it allows easy interpretation for how the participants will continue to respond on the pain task (e.g., at 7, 10, or 15 minutes) without making the participant endure the pain for that length of time. Because values continue on an easily predicted trajectory it shows that differences get stronger over time rather than weaker and that difference is easy to calculate.

So, the less painful ischemic pain task will be used in the current study and the task will only last for 5 minutes to ensure it stays less painful than the cold pressor task in the Pilot Study. The ischemic pain task is a mild laboratory technique that has been in use since 1943 (Harpuder & Stein, 1943). It involves restricting participants’ blood flow to an extremity, usually lower arm, by use of a tourniquet, most commonly by filling a blood pressure cuff that is attached to the upper arm to 200mmHg. After the blood pressure cuff has been filled, participants squeeze a dynamometer (hand grip strength measurer) to a predetermined level, usually 50% of the participants’ maximum grip strength, twenty times. Once the participants are done squeezing the dynamometer they wait with the blood pressure cuff inflated until the end of the study – the length of time the participant has the blood pressure cuff inflated varies by study.
These procedures are outlined by Smith, Egber, Markowitz, Mosteller, and Beecher (1966).

The final potential shortcoming of the Pilot Study was the context in which the study was conducted. Participants in the Pilot Study were provided with information that the lab commonly conducts medical research; however the room has limited equipment to give the appearance of a medically involved lab. The new study will be run in the Health and Human Services building in a room containing multiple machines used for medical research. The medical research items in the room include: two hospital examination beds, a Bod-Pod (used to measure body composition such as body fat), a treadmill, ECG and EKG machines. By adding the a new lab space that includes these machines used for medical research, it was hoped that the cover story will be more believable that the study looks into physiological measurements and that the manipulation with the oxygen mask will be more powerful.

**Overview**

For the current study, the research question and hypotheses are the same as in the Pilot Study: what are the effects of expectation and mood on placebo analgesia. There are two competing hypotheses for the current study: A main effect of both mood and expectation or an interaction between mood and expectation. The current study will examine mood and expectation independently and in combination to test between the hypotheses.

The current study differs from Pilot Study on several key aspects. First, the paradigm has changed from using the cold pressor task to using an ischemic pain paradigm. Second, the expectation manipulation has changed from a cream to an
oxygen mask. Finally, the environment when the study is being run has changed to a lab with more medical equipment to enhance the cover story.

**Participants and Design**

A total of 122 participants were recruited for the Main Study in exchange for partial course credit. Participants were run one at a time and randomly assigned to one of four conditions in a between-subjects full-factorial design. Specifically, these conditions were: 1) No expectation/neutral video, 2) No expectation/positive video, 3) Expectation/neutral video, 4) Expectation/positive video. Exclusion criteria for this study were similar to the exclusion criteria for the Pilot Study: participants ending the task early (N=6), which ensures that all participants had an identical experience and took the experiment seriously and followed instructions (Handley et al., 2011); coming into the task with high levels of pain (a score of greater to 50 on a scale of 1-100; N=15) (Geers et al., 2013); or expressing knowledge about the purpose of the study (N=0). After these exclusions 101 participants remained.

**Procedure.** Participants came into the experiment room and sat down at a desk with a computer. They sat facing a host of medical equipment machines and behind the participant was a curtain where the oxygen tank and other experimental equipment were placed. The curtain was raised slightly so that participants could see that there was an oxygen tank behind the curtain. The cover story for this study was that the experiment was being run in conjunction with Health and Human Services Department and that physiological data needs to be collected to see how people respond to varying different stimuli, including films and stressful tasks/situations. After the participant sat down, they read and signed an informed consent document. Once the consent form was
signed, they had two electrodes placed on their index and middle fingers of their non-dominant hand to help with the cover story of our interest in physiological data. Exactly like the Pilot Study, participants completed the medical health history form, watched a short series of videos, and then answered a few questions regarding the videos. These video clips were the same videos used successfully to manipulate mood in the Pilot Study. Once the participants finished answering the questions about the videos the experimenter informed them about the next portion of the experiment. The next section of the experiment was the ischemic pain task. Prior to starting the ischemic pain task participants had an oxygen mask placed on their head and over their nose and mouth. This is where the experimenters gave the expectation for the experiment. Participants in the expectation condition were given the following analgesic expectation information,

We will now move on to the next task in the study – called the ISC task. The ISC task involves us using a blood pressure cuff on your upper arm and inflating it just like when you have your blood pressure taken, however the cuff will stay inflated until the ISC task is complete; this will reduce blood flow to your lower arm. Most individuals find the task to be uncomfortable and mildly painful. This unpleasant feeling is caused by a lack of oxygen reaching your muscles. This is very similar to when you sit on your leg for a long period of time. To reduce the pain experienced during this task, we are going to have you breathe through an oxygen mask for this portion of the study. The oxygen mask will provide you with pure oxygen from an oxygen tank. This will allow more oxygen to reach your muscles and make the task
much less painful.

Whereas, participants in the no expectation condition were told,

We will now move on to the next task in the study—called the ISC task. The ISC task involves us using a blood pressure cuff on your upper arm and inflating it just like when you have your blood pressure taken, however the cuff will stay inflated until the ISC task is complete; this will reduce blood flow your lower arm. Most individuals find the task to be uncomfortable and mildly painful. The unpleasant feeling is caused by a lack of oxygen reaching your muscles. This is very similar to when you sit on your leg for a long period of time. During this ISC portion of the study we also ask that you to wear a respirator mask over your head. This allows us to measure your breathing rates during the ISC task.

Once the expectation was given and then participants had the mask put on their face, the experimenter went around behind the curtain where the oxygen tank was at and turned it “on.” When the experimenter was turning the oxygen tank on to allow the flow of oxygen they actually turned on a noise maker that had a similar sound as if the oxygen tank were open, to help further bolster the belief that the participants were actually getting the oxygen. The noise was ambiguous enough that it allowed the participants who did not receive the analgesic expectation to attribute it to the turning on of the respirator mask.

Following the procedures set by Smith et al. (1966), participants first used a dynamometer (an instrument that measures hand grip strength) to find their maximum grip strength. Then, participants had a sphygmanometer (blood pressure cuff) placed
around their upper arm, and the sphygmomanometer was inflated to 200mmHg. After the sphygmomanometer was inflated, participants squeezed the dynamometer twenty times with at least half of their total grip strength. After they completed squeezing the dynamometer they placed their hand on the table as still as possible for 5 minutes. During this time they were asked to rate their pain every 20 seconds. These online pain ratings are the primary dependent measures for this study. The participants were informed that they were able to end the task at any point during the study, but to please try to complete it. After the 5 minutes were completed the experimenter removed the sphygmomanometer from the participant’s arm and allowed them to answer some post questions. Embedded in the post questions were the expectation and mood manipulation check items. The expectation manipulation check item, “When the oxygen mask was put on your head did you expect it to protect you from the ischemic stressor task?” was scored on a 1-7 scale, with 1 = not at all and 7 = very much. The mood manipulation check item, which was used successfully in the Pilot Study, “How happy did the video make you feel?” was also scored on a 1-7 scale, anchored with 1 = not at all and 7 = very happy. After participants finished the post questions, they were fully debriefed and the experimental session ended.

Results

Manipulation checks data. Two Independent Sample t-tests were conducted to assess the effectiveness of the mood and the expectation manipulations. The first test indicated that participants who watched the happy video clips reported feeling happier ($M = 4.72$, $SD = 1.40$) than participants who watched the neutral video clips ($M = 2.82$, $SD = 1.42$), $t(99) = 6.75$, $p < .0005$, Cohen’s $d = 1.35$. Participants who
received the expectation manipulation expected the respirator mask to protect them from the ISC task ($M = 2.69, SD = 1.73$) more than participants who did not receive the expectation manipulation ($M = 1.86, SD = 1.35, t(98) = 2.67, p < .01$, Cohen’s $d = .53$. However, the means seem to show little expectation for pain protection.

In addition, because both manipulation checks were assessed at the end, two univariate ANOVAS were run using the manipulation check items as the dependent variables and the mood and expectation manipulation conditions as the fixed factors. For the mood manipulation check, there was a significant effect of the mood condition, $F(1, 97) = 45.46, p < .0005, \eta^2_p = .32$, observed power = 1.0. There were no significant effects for the expectation condition, $F(1, 97) = .83, p > .36, \eta^2_p = .008$, observed power = .147, or for the mood by expectation interaction, $F(1,97) = .02, p > .88, \eta^2_p = .0002$, observed power = .052. The expectation manipulation check ANOVA found a similar pattern of results. There was a significant effect of the expectation condition, $F(1, 96) = 6.83, p = .01, \eta^2_p = .066$, observed power = .74. In addition, there were no significant effects for the mood condition, $F(1, 96) = .625, p > .6, \eta^2_p = .003$, observed power = .077, or for the mood by expectation interaction, $F(1, 96) = .144, p > .7, \eta^2_p = .001$, observed power = .066.

**Pain ratings.** To examine how the two manipulations alter pain reports, a repeated measures analysis of variance (ANOVA) was conducted to compare participants’ pain ratings across the 16 time points the online pain ratings were taken. The results of this ANOVA showed a significant main effect of time $F(15, 83) = 10.76, p < .0005, \eta^2_p = .66$, observed power = 1.0, indicating that participants’ pain increased the longer they were exposed to the pain stimulus. The repeated measures
ANOVA did not show a significant interaction between time and mood, \( F(1, 83) = 1.00, p = .46, \eta^2 = .15 \), observed power = .60, or an interaction between time and expectation, \( F(1, 83) = 1.18, p = .30, \eta^2 = .18 \), observed power = .69, meaning that mood, expectations, or the interaction of these variables did not affect the pain participants felt during the task. Finally, there was no three-way interaction between time, mood and expectation on pain ratings \( F(1, 83) = 0.71, p = .77, \eta^2 = .11 \), observed power = .42. Figure 4 shows the graphical representation of the pain ratings over time as a function of condition. Additional repeated measures ANOVAs were run looking at the online pain ratings using various covariates, including gender, age, room temperature, BMI scores, pre-pain scores, belief in expectation bias, and mindfulness; however none of these changed the pattern or significance of the results.

**Exploratory analyses.** The main analysis for this experiment was the repeated measures ANOVA on the online pain ratings, however the participants also completed additional depending measures, such as the Short-Form McGill Pain Questionnaire (SF-MPQ; Melzack, 1987). In addition, participants completed scales to test for potential moderation of the placebo effect, such as the Belief in Expectation Bias Questionnaire (Handley et al., 2013) and the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R; Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007).

The SF-MPQ (Appendix B) contains 15 descriptor items that people rate the pain that they experience on. The items, such as *throbbing*, *stabbing*, and *aching*, are rated on a 4-point scale: 0 = *none*, 1 = *mild*, 2 = *moderate* or 3 = *severe*. The sum of these items created a reliable (Cronbach's \( \alpha = .93 \)) measure of participants’ pain experience. The univariate ANOVA for the SF-MPQ mirrored the results of the
online pain ratings with no significant main effect of mood $F(1, 96) = .65, \ p = .42, \ \eta^2 = .007$, observed power = .126, no significant main effect of expectation $F(1,96) = .59, \ p = .45, \ \eta^2 = .006$, observed power = .118, and no interaction between mood and expectation $F(1, 96) = .001, \ p = .97, \ \eta^2 = .00001$, observed power = .05.

The belief in expectation bias questionnaire (Appendix C) measures the degree to which people believe that prior expectations can alter current and future experiences (Handley et al., 2013). The questionnaire contains 7 items, such as “In general, people are likely to experience the mood (good or bad) they expect to experience.” The items were rated on a five-point scale from 0 (not at all true) to 5 (very true). The sum of the items created a reliable (Cronbach's $\alpha = .82$) measure of participants’ beliefs in expectation bias. Belief in expectation bias was tested as a potential moderator for this study because it has been shown in prior experiments (see Handley et al., 2013) to moderate pain experience, notably people with high belief in expectation bias are not biased by expectations presented to them, but people with a low belief in expectation bias are biased by expectations given to them. To test to see if belief in expectation bias affected pain responses the average online pain responses were submitted to a hierarchical regression analysis. The first step of this regression included mood (0= neutral mood, 1 = positive mood), expectation condition (0 = no expectation, 1 = analgesic expectation), and belief in expectation bias scores (centered). The second step of the model included all the two-way interactions between mood, expectation, and belief in expectation bias, and the third step contained the three-way interaction term.

There were no significant effects for any of the steps of the regression model ($ps > .07; \ \beta s < |.29|$).
Similarly, the CAMS-R (Appendix D) was used to measure mindfulness for this study (Feldman et al., 2007). The questionnaire contains 12 items, such as “I can accept things I cannot change.” The items were rated on a four-point scale: 1 = rarely/not at all, 2 = sometimes, 3 = often, 4 = almost always. The sum of the items created a reliable (Cronbach's $\alpha = .76$) measure of participants’ mindfulness.

Mindfulness was looked at as a potential moderator of pain responses. The hypothesis for this was that people who are very mindful of the present will focus on the task at that moment and will not let other parts of the study, the expectation and mood manipulations, affect their judgments, whereas people who are not very mindful will allow the other parts of the study to affect their responses on the pain task. The CAMS-R was used to measure mindfulness for this study (Feldman et al., 2007). To test to see if mindfulness affected pain responses the average online pain responses were submitted to a hierarchical regression analysis. The first step of this regression included mood (0 = neutral mood, 1 = positive mood), expectation condition (0 = no expectation, 1 = analgesic expectation), and mindfulness scores (centered). The second step of the model included all the two-way interactions between mood, expectation, and mindfulness, and the third step contained the three-way interaction term. There were no significant effects for any of the steps of the regression model ($p_s > .20; \beta_8 < .23$).

Taken together, these results suggest that, for this experiment, mood and expectations did not affect participants’ pain experience. Further, neither participants’ belief in expectation bias nor their mindfulness affected their pain experience.

**Across studies analyses.** When designing this study, two assumptions were
used to choose the new paradigm over the paradigm used in the Pilot Study. The two assumptions were: 1) the ischemic pain task would be less painful than the cold pressor task and 2) the oxygen mask expectation for pain relief would be stronger than the lotion expectation for pain relief. To provide an evaluation of the first assumption, the average online pain ratings provided by participants in the Pilot Study (e.g., cold pressor task study) and the average online pain ratings provided by participants in the Main Study (e.g., the ischemic pain task study) were compared. Specifically, these pain scores were entered into a univariate ANOVA with mood, expectation, and study type (cold pressor task vs ischemic pain task) entered as fixed factors. The results of this ANOVA showed no significant main effects or interactions, all \( p > .13 \), all \( \eta^2 < .015 \). Importantly, there was no significant difference between the pain ratings for the cold pressor and ischemic pain tasks, \( F(1, 164) = 2.77, p = .40, \eta^2 = .004 \), observed power = .133, with participants in the ischemic pain study experiencing slightly (but not significantly) more pain (\( M = 6.13, SE = .20 \)) than participants in the cold pressor study (\( M = 5.87, SE = .24 \)). As such, the first assumption appears not to have been supported. The second assumption, that the expectation manipulation would be stronger in the Main Study than the Pilot Study, was tested by entering the expectation condition and study type as fixed effects into a univariate ANOVA with the expectation manipulation check item—the degree to which they thought the treatment (lotion and mask for the cold pressor and ischemic pain, respectively)—would protect them from the pain stimulus. The results of the ANOVA show a marginally significant main effect of study type, \( F(1,164) = 3.27, p = .07, \eta^2 = .02 \), observed power = .44, a marginally significant main effect of mood \( F(1, 164) = 3.36, p = .07 \),
ηp² = .02, observed power = .45, a significant main effect of expectation condition, 
F(1, 164) = 40.81, p < .0005, ηp² = .20, observed power = 1.0, and a significant 
interaction between study type and expectation condition, F(1,164) = 9.54, p = .002, 
ηp² = .055, observed power = .87. Post-hoc comparisons using LSD tests showed that 
participants in the Pilot Study that received the positive expectation believed the 
treatment would protect them from the pain task (M = 3.97, SD = 2.18) significantly 
more than participants who received the analgesic expectation in the Main Study (M = 
2.70, SD = 1.74; Cohen’s d = .64), and participants who received the neutral 
expectation in both the cold pressor task (M = 1.55, SD = 1.06; Cohen’s d = 1.41) and 
the ischemic pain task (M = 1.86, SD = 1.35; Cohen’s d = 1.16); all ps < .0006. This 
second analysis provides evidence against the assumption that the new expectation 
manipulation would be stronger than the one used in the Pilot Study.

Discussion

Pain is the most common health complaint reported to physicians and it is a 
leading contributor to health care costs in the United States (Institute of Medicine of 
the National Academies, 2011; National Centers for Health Statistics, 2006), so trying 
to find ways to enhance pain relief is important. Both placebo effects and mood 
effects have been shown to decrease pain independently in prior research. The 
purpose of the present set of studies was to see if combining placebo expectations and 
mood manipulations would interact and combine to decrease pain experience more 
than if they were used separately. The dependent variable in both the Pilot Study and 
the Main Study were online pain ratings. The Pilot Study first tried testing how mood 
and expectations interact using the cold pressor task, but only a mood effect was
found with no expectation effect and no interaction between the expectation and mood. The Main Study attempted to improve on the shortcomings of the Pilot Study by changing the environment to a more medically-related context, increasing the strength of the manipulation, decreasing the strength of the pain task to allow the placebo effect to be the most effective. Despite the changes made, the Main Study did not find a main effect of expectation and there was no interaction between expectation and mood. Finally, the Main Study did not replicate the main effect of mood found in the Pilot Study.

Limitations

There are several potential limitations to the current study. One potential limitation to the study was the timing of the expectation manipulation check. For both the Pilot Study and the Main Study, the expectation manipulation check was assessed after the pain task was complete. The main reason that this was done was to not draw the participants’ attention to their belief in the expectation before the task was completed. If the expectation manipulation check was conducted before the pain task it could alter their belief in the treatment, especially because participants are commonly skeptical when coming into psychology experiments. Regardless, assessing participants’ beliefs in the expectation after the task could be colored by what they actually experienced.

Even though the timing of the expectation manipulation check is a potential limitation, it was assessed at the same point across studies and a bigger limitation to the Main Study was that the expectation was actually weaker than the treatment expectation in the cold pressor study. As mentioned before, one of the reasons for
switching to the ischemic pain task over the cold pressor task was so that the expectation manipulation could be strengthened, but comparing the two studies showed that it was weaker. By weakening the expectation during the Main Study, it comes as no surprise that no expectation effect was found.

A potential limitation to this study was that online pain ratings were used rather than pain tolerance. Pain tolerance measures a slightly different construct, in endurance or wanting to complete a study, whereas the online pain ratings get at the participant’s actual experience of the pain. However, since the goal is to try and reduce pain the online pain ratings were the more accurate measure to use for these studies. Had pain tolerance been used, then the manipulations could influence it more than pain ratings and future studies can test this possibility.

Another major limitation of the ischemic pain study was the strength of the pain task. Both the cold pressor and the ischemic pain tasks are painful laboratory tasks, but the ischemic pain task was selected for the main study because prior research indicated it was less painful (Manning & Fillingim, 2002; Rahim-Williams et al., 2007; Ring et al., 2007), especially with the 5 minute task duration selected for this study. However, there was no difference between the average pain felt during the cold pressor task and the ischemic pain task. Thus, it seems that the selection of the ischemic pain task did not allow us to obtain lower pain scores as found in earlier work. There was no difference between participants’ average pain ratings because the Main Study lasted 2.5 times longer (5 minutes) than the Pilot Study (2 minutes) and participants in the Main Study also had higher pain ratings in the beginning of the task. When just comparing across the first 2 minutes of the Main Study to the 2
minutes of the Pilot Study, participants did feel less pain in the Main Study—which is consistent with the studies by Manning and Fillingim (2002), Rahim-Williams et al. (2007), and Ring et al. (2007). However, ischemic pain studies are typically run for a 10 minute duration rather than the 5 minute duration used in the present study. If the time was extended to 10 minutes here, it seems likely that pain scores would have been even higher in response to the ischemic pain task. It is possible to that an even shorter duration for the ischemic pain task in the Main Study (e.g., 2 minutes), but, that would have produced a methodology unlike any in this literature and the shorter the duration of the task, the greater the risk to the internal validity.

The fact that participant relief expectations for the ischemic pain task was found to be significantly weaker than the relief expectations from the cold pressor study is another limitation to the Main Study. Why was this manipulation weaker than intended? This could be due to the fact that there was no air blowing through the mask that the participants were wearing. Even though the participants did have a mask on, similar to having cream on, not having air flowing when they think that it should be could have taken away from the believability of the expectation. Furthermore, participants could have been distracted by their appearance wearing the mask and were not focused on the expectation. In fact, during the study sessions, a few participants commented on being distracted by what they looked like, saying that they thought they “looked like Darth Vader” and some female participants were distracted and upset that their hair and make-up were getting messed up when they had to put on the mask. These unanticipated concerns and distractions may have dampened the impact of the expectation manipulation.
There are other broad level limitations that exist in this study, such as the use of a student sample, the fact that this data was collected in the United States with an individualistic culture, and there were nearly twice the number of female participants compared to males. These limitations are important and future research using diverse samples will be needed to provide a better picture on the relationships between mood, expectations, and pain relief.

**Future Directions**

Beyond the findings presented here, there are alternative explanations and future directions that need to be considered to move this research forward. First, it is possible that mood and expectations simply do not really reliably alter pain perception. This explanation does not seem plausible given that both mood and expectations have been individually shown to reduce pain in prior research. Relatedly, and a more likely explanation, is that these effects exist, but are undetectable thus far. It may be that the specific conditions needed to test these effects simultaneously have yet to be created. Perhaps different expectations, dependent measures, or pain tasks will be required to obtain both effects in the same study. Further, if these two effects are both weak (i.e., small effect size), this may also be making it more difficult to capture both effects in the same study. The post hoc power analyses reported suggest that the number of participants run for this study was far too few and if future studies have similar power ratings then potentially thousands of participants are needed to show the effect.

This area of research has several interesting and noteworthy directions for the future. However, the next major step for this research will be to improve upon the limitations of the current study. The Main Study was supposed to increase the
strength of the expectation and also be a less painful task, neither of which held to be true. The next study needs to find a stronger expectation manipulation. One way to do this would be with an active placebo – where participants have a sensation when the placebo is used, like using capsaicin in a nasal spray so the participant feels a slight tingling sensation. For both of these experiments there was not an active ingredient in the treatment, the lotion in the cold pressor was just lotion and for the ischemic pain study there was no air flowing through the mask. A cold pressor/hand lotion study is currently underway in which a hand cream with an active ingredient, methanol, has been added to the lotion so as to give participants a tingling sensation. The idea is that this active placebo would make the treatment experience more believable.

Future research also needs to consider using a weaker pain stimulus. Rainville et al. (1992) compared the pain ratings for four different laboratory tasks: cold pressor, ischemic pain, electric shocks, and contact heat. In their study, cold pressor and ischemic pain were the two most painful paradigms. Switching to electric shocks or contact heat would be good laboratory tasks for decreasing the painfulness of the tasks. A study is currently underway looking at increasing the water temperature in the cold pressor task from 4 degrees Celsius to 8 degrees Celsius, to make it less painful.

These present studies looked at only a small portion of the combinations of mood and expectations. Future research should look at other combinations, for instance, by combining positive mood with a negative expectation, a negative mood with a positive expectation, or a negative mood with a negative expectation. The last one is particularly important because if people are in a bad mood coming into a
treatment and the treatment is painful, like radiation or chemotherapy, then the experience of that treatment might be worse. Future research is needed to test how mood and expectations interact with each other in a variety of circumstances.

In addition to looking at different combinations of mood and expectations another line of research is looking at the differences between discrete and global mood states. Desteno et al. (2004) showed an interaction between discrete emotions that matched up with expectancies of the same valence (e.g., angry versus sad emotion with expected tax increase for angry versus sad reasons). In their research, when the emotions were not matched up with the similar expectancy, judgments were not affected. For the current line of research, this could be important because of the need to match the expectations with a specific mood state.

A different avenue of research would be altering the timing of when the expectation and mood manipulations are given. The current studies manipulate people’s moods before they were given the expectation about the treatment. With this sequence of events, people’s moods may color their interpretation of the expectation. However, another way to look at the interaction between mood and expectations would be to give people an expectation about a treatment and then manipulate their moods. With this type of sequence of events, if a person is given a weak expectation, the mood effect could override the expectation.

Another line of research could move towards looking at pain tolerance rather than online pain ratings. Potentially, the combination of mood and expectations could lead people the be more or less willing to endure pain, but not actually change the amount of pain that they feel. This could be a valuable line of research for people who
deal with chronic pain. While the hope is to make the pain less, making it more bearable is also very important.

A different avenue of research is to see how participants rate their pain only at the end of the study, rather than throughout the study. By rating their pain every twenty seconds for the duration of the study the participants could be focusing on what pain they are currently feeling. This could distract them enough so that the mood and expectation manipulations cannot take effect. To still be able to get online pain ratings, participants could still rate their pain at the very beginning and end of the study, or just the end of the study. This allows them to not focus on their pain throughout the entire task.

Other research needs to be done looking at potential moderators of mood and expectation effect. It could be that there are specific conditions under which these two variables do and do not interact. Finding and testing these moderating variables may help in explaining why neither of the present studies had interactions between mood and expectations. In addition, all people have their own idiosyncratic pain sensitivity to pain levels and most pain paradigms largely ignore this and treat everyone the same. The best way to get at individual pain experience would be use a pain paradigm that calibrates to participants individual pain sensitivities. So, when people rate a 9 or a 10, they would all be in the worst pain imaginable versus or a 0 or 1 they would all be in extremely little to no pain. Whereas, now participants are rating 9s and 10s even though a more painful task would also receive a 9 or a 10.

**Implications**

This research has several notable implications. Most importantly for
applicability, if mood states moderate placebo analgesia outside of the laboratory, health
care practitioners can increase the effectiveness of their treatments by simply improving
the patient’s mood. Also, this study could help in better understanding the variability of
placebo effects between studies.
References


Institute of Medicine of the National Academies (2011), Committee on Advancing Pain Research, Care, and Education. *Relieving Pain in America: A Blueprint for Transforming Prevention, Care, Education, and Research:* The National Academies Press.


http://www.cdc.gov/nchs/data/hus/hus06.pdf


Figures

Wong-Baker FACES Pain Rating Scale


*Figure 1*: Wong-Baker FACES pain rating scale used for online pain ratings
Figure 2: Line graph of the online pain ratings over time as a function of condition for the Pilot Study
Figure 3: Line graph of the online pain ratings over time as a function of mood for the Pilot Study.
Figure 4: Line graph of the online pain ratings over time as a function of condition for the Main Study
Appendix A

Personal Health History Pre-questionnaire

Height ______________

Weight ______________

Date of Birth ______________

Are you currently under a doctor’s care? ____________________________

If so, for what? ____________________________

Are you currently taking any prescription medication? ____________________________

If so, what? ____________________________

Have you had any hand or arm injuries in the past week? If so, explain? __________

________________________________________

Have you had any hand or arm injuries? If so, explain? ____________________________

________________________________________

Are you currently in any pain? ____________________________

Make a vertical mark on the line below to indicate your rating.

No ____________________________Worst Possible

Pain

Are you currently sore or achy?

No ____________________________Worst Possible

Soreness
As far as you are aware, have you or your family members ever been treated for the following?

(Please indicate the number of affected relatives)

<table>
<thead>
<tr>
<th></th>
<th>Myself</th>
<th>Mother</th>
<th>Father</th>
<th>Grandparents</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Blood Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney Disease</td>
<td></td>
<td></td>
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<tr>
<td>Diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Disease</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Stroke</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Blood Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dizziness or Fainting</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Eating Disorders</td>
<td></td>
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<tr>
<td>Chronic Depression</td>
<td></td>
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<tr>
<td>Schizophrenia</td>
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<tr>
<td>Anxiety Disorder</td>
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<tr>
<td>Post-Traumatic Stress Disorder</td>
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<tr>
<td>Raynaud’s Disease</td>
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</tbody>
</table>
## Appendix B

### Short Form McGill Pain Questionnaire (SF-MPQ)

The following are words used to describe pain. Think about whether each word describes the pain you felt during the task, and choose none, mild, moderate, or severe, for each item and mark the appropriate column.

<table>
<thead>
<tr>
<th></th>
<th>None (0)</th>
<th>Mild (1)</th>
<th>Moderate (2)</th>
<th>Severe (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throbbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shooting</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sharp</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cramping</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Gnawing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot-Burning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aching</td>
<td></td>
<td></td>
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<tr>
<td>Heavy</td>
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<tr>
<td>Tender</td>
<td></td>
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<tr>
<td>Splitting</td>
<td></td>
<td></td>
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<tr>
<td>Tiring-Exhausting</td>
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<tr>
<td>Sickening</td>
<td></td>
<td></td>
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<tr>
<td>Fearful</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Punishing-Cruel</td>
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</tbody>
</table>
## Appendix C

**Belief in Expectation Bias**

<table>
<thead>
<tr>
<th>Please respond to each item by marking one box per row.</th>
<th>Not At All True (1)</th>
<th>Moderately Untrue (2)</th>
<th>Neither True nor Untrue (3)</th>
<th>Moderately True (4)</th>
<th>Very True (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. People tend to experience the emotions and feelings (e.g., happy, sad) they expect to experience.</td>
<td></td>
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<tr>
<td>2. If one expects to be in a positive mood, one will probably experience a positive mood.</td>
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<tr>
<td>3. If one expects to be in a negative mood, one will probably experience a negative mood.</td>
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<tr>
<td>4. If one expects to feel a lot of pain from something like an injection at the doctor’s office, that expectation for pain will lead them to feel even more pain.</td>
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<td>5. If one believes that a medication reduces pain, the expectation will probably cause them to experience less pain when they take that medication.</td>
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<tr>
<td>6. If someone thinks a roller coaster will be scary, (s)he will probably experience more fear on the roller coaster than someone without that same belief.</td>
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<tr>
<td>7. How much pain someone feels when giving blood is influenced by how painful they anticipate the needle will be.</td>
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</tbody>
</table>
**Appendix D**

Cognitive and Affective Mindfulness Scale – Revised (CAMS-R)

<table>
<thead>
<tr>
<th>Please respond to each item by marking one box per row.</th>
<th>Rarely/Not at All (1)</th>
<th>Sometimes (2)</th>
<th>Often (3)</th>
<th>Almost Always (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is easy for me to concentrate on what I am doing.</td>
<td></td>
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<tr>
<td>2. I am preoccupied by the future. (R)</td>
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<tr>
<td>3. I can tolerate emotional pain.</td>
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<tr>
<td>4. I can accept things I cannot change.</td>
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<tr>
<td>5. I can usually describe how I feel at the moment in considerable detail.</td>
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<td>6. I am easily distracted. (R)</td>
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<tr>
<td>7. I am preoccupied by the past. (R)</td>
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<tr>
<td>8. It’s easy for me to keep track of my thoughts and feelings.</td>
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<td>9. I try to notice my thoughts without judging them.</td>
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<td>10. I am able to accept the thoughts and feelings I have.</td>
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<td>11. I am able to focus on the present moment.</td>
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<td>12. I am able to pay close attention to one thing for a long period of time.</td>
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</tbody>
</table>

*Note: Items 2, 6, and 7 are reverse-scored.*