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Dispositional Optimism Predicts Placebo Analgesia

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Abstract

Based upon prior research identifying dispositional optimism as a predictor of placebo responding, the present study tested the hypothesis that individuals high in optimism would be more likely to respond to a placebo analgesic. Optimists and pessimists were randomly assigned to a placebo expectation condition or a no expectation condition prior to a cold pressor task. Blood pressure and heart rate were recorded before and during the cold pressor task, and participant ratings of pain and expectations were obtained immediately after the task. Analysis of the expectation manipulation revealed that the placebo instruction was successful in altering participant expectancy during the cold pressor. Supporting the main hypothesis, dispositional optimism was associated with lower pain ratings in the placebo condition but not in the control condition. Because dispositional optimism can alter placebo responding to laboratory pain, future studies should examine the potential role that this individual difference factor may play in patient responsivity to pharmacological and non-pharmacological treatments for clinical pain.

Keywords

Placebo Effect; Placebo Analgesia; Cold Pressor; Optimism; Pain

Introduction

The placebo effect is a physiological and/or psychological reaction to an inactive substance or procedure.[15, 41] This phenomenon represents a key interface between physiology, psychology, and patient care.[7, 20, 29] Recently, there has been increased attention devoted to the placebo effect, particularly as it relates to the experience of analgesia (i.e., decreased pain perception).[4, 6, 30–32] For example, research has demonstrated that the desire for reduced pain predicts placebo analgesia[31] and that placebo analgesia can be mediated by endogenous opiates.[4, 6, 32] Understanding predictors of placebo analgesia is important, as treatments for both acute and chronic pain can benefit from clinically meaningful placebo effects.[9, 23, 24, 42, 44] Interestingly,

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few have examined the possibility that personality variables may alter placebo analgesia despite the potentially important theoretical and practical implications.[12, 13] From a theoretical perspective, examination of individual difference factors could further elucidate mechanisms by which placebo effects occur, as well as provide additional insight into the personality component of pain and healing. On the practical side, this information could help health care professionals identify those patients who are most likely to benefit from the placebo component of an analgesic treatment.

One potential predictor of placebo responding is dispositional optimism, which refers to a generalized positive outcome expectancy for the future.[8, 33] A substantial literature on dispositional optimism indicates that, when faced with adversity, optimism is associated with active behavioral and mental coping.[8, 33, 39] Several lines of research converge to show that optimists often shift their focus away from adversity to the more positive features of the situation—especially when dealing with adversity that is out of their control.[10, 19, 21, 35–37, 40, 43] In one study, for example, optimistic early-stage breast cancer patients found greater benefits in their experience with cancer than pessimistic patients. Amongst individuals recovering from coronary artery bypass surgery, Scheier et al.[35] found that optimists were more likely to focus on their recovery and less likely to dwell on their post-surgery negative affect than pessimists. Further, laboratory studies indicate that optimists display an attentional bias for positive stimuli[19, 21, 37] and are more likely than pessimists to cognitively elaborate on, and be persuaded by, a positively framed message.[10]

Based on this research, Geers et al.[13] hypothesized that optimists would be more likely than pessimists to be influenced by positive placebo expectations. To test this hypothesis, individuals were randomly assigned to one of three conditions. In the first condition, participants were given the expectation that a placebo sleep treatment would improve their sleep quality (placebo-expectation condition). In the second condition, participants engaged in the same sleep treatment activity but were not given the positive placebo expectation (treatment-control condition). Finally, a third group did not receive the placebo expectation and also did not engage in the placebo sleep treatment (no-placebo control condition). The results revealed that optimism was positively associated with reports of better sleep quality in the placebo-expectation condition, but not in either the treatment-control condition or the no-placebo control condition. To determine whether similar effects would be observed in the context of anticipation of painful stimulation, the present study examined the effects of dispositional optimism on cold pressor pain responsivity following placebo analgesia versus control expectancy manipulations.

Material and Methods

Participants

One hundred and sixteen (60 female, 56 male) adults with no reported history of chronic pain were recruited for the study. Participants were non-smokers who had not exercised during the hour prior to the experiment. Participants ranged in age from 18 to 45 years (M = 20, SD = 3.4). Eighty-one were White, 18 were Black, 11 were Asian, and 6 did not specify race. All procedures were approved in advance by the Institutional Review Board of the University of Toledo. All participants received partial course credit in return for their participation.

Design and Hypotheses

Participants prescreened for dispositional optimism earlier in the semester were exposed to a cold pressor task for two minutes. Prior to this task, participants had an inert cream applied to their hand. By use of a random number generator, participants were randomly assigned to receive one of two different set of information about the inert hand cream. Participants in the

placebo condition were told the cream would block the pain from the cold pressor, whereas participants in the control condition were told the cream was a hand cleanser. To assess pain sensitivity, participants completed the short form of the McGill Pain Questionnaire[25] (SF-MPQ) immediately following the cold pressor task. Participants also answered an expectation-manipulation check question. Blood pressure and heart rate were recorded before and during the cold pressor task.

Procedure

Dispositional optimism—Participants completed a packet of prescreening questionnaires earlier in the semester which included a measure of dispositional optimism: The Life Orientation Test-Revised[34] (LOT-R). The LOT-R assesses generalized positive outcome expectancies and contains six self-report items (plus four filler items), each rated on a five-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*). To calculate dispositional optimism scores, the three negatively worded items (e.g., I hardly ever expect things to go my way) were reversed scored and averaged together with the three positively worded items (e.g., I'm always optimistic about my future) to create a summary optimism score (M = 2.39, SD = .70, range = .17 to 4, α = .80). Substantial research supports the reliability and validity of the LOT-R instrument.[10, 34, 39]

Baseline recoding—Upon arrival to the experimental sessions, participants read and signed an informed consent document and completed a health history questionnaire. Participants then relaxed for 10 minutes to obtain resting baseline readings of blood pressure (mmHg) and heart rate (bpm) measured at 2 minute intervals using a GE Medical Systems Dinamap Pro Series 100 Vital Signs Monitor, thus providing 5 blood pressure and heart rate baseline readings for each participant. After this baseline period, participants completed a neutral sentence scramble task for 3 minutes. Blood pressure and heart rate were recorded during this second period to obtain a second set of baseline blood pressure and heart rate readings. During this task, blood pressure and heart rate were recorded at 1 minute intervals, resulting in three additional blood pressure and heart rate readings. As the initial 5 resting baseline readings were lower, these baseline readings were used in data analysis. After these baseline recording periods, participants received either placebo expectation or control instructions prior to immersing their hand in a container filled with water and crushed ice.

Placebo-expectation manipulation—Similar to procedures successfully employed in other placebo analgesia studies,[26,27, 31] participants in the *placebo condition* were told that the researcher was interested in a new topical, local anesthetic that was being tested for its pain-reducing effects. Participants were told the drug's name was Trivaricane and that this drug had been proven effective in reducing pain in preliminary studies at other universities. Participants were further told that this topical drug was very powerful and would eliminate a great deal of the pain normally caused by the cold pressor task. The experimenter (wearing surgical gloves) then opened up a bottle labeled "Trivaricane: Approved for research purposes only" and applied the placebo cream to the entire hand (from the wrist down) of their non-dominant arm. The placebo cream was a mixture of iodine, oil of thyme, food coloring, and lotion that created a light brown, medicinal-smelling cream. Placebo-expectation participants were told that it would take 30 seconds for the Trivaricane to begin numbing their hand. Participants in the *control condition* had the same topical cream applied to the hand of their non-dominant arm. The control participants, however, were not given the placebo expectation but rather were told that the cream was a hand-cleaning product used in this type of experiment. The bottle containing the cream applied to the hand of control participants was labeled "Soft clean hand cleanser".

The cold pressor task—After the placebo manipulation, participants placed their non-dominant hand up to their wrist in a container of approximately 4° Celsius water and crushed ice. The water in the bath did not circulate and participants' hands had contact with the crushed ice. Participants were instructed to keep their hand in the water for 2 minutes but were told they could withdraw their hand if it became unbearable. Blood pressure and heart rate were recorded every thirty seconds during the task.

Dependent measures—Participants reported their pain immediately after removing their hand from the ice water using the SF-MPQ.[25] The SF-MPQ is comprised of an overall pain rating index, a visual analogue scale, and a pain intensity scale. For the overall pain rating index, participants indicated the degree to which they experienced 15 affective and sensory pain descriptors (e.g., stabbing, punishing-cruel) using a four-point scale ranging from 1 (*none*) to 4 (*severe*). The affective and sensory items can be analyzed separately or combined. As the affective and sensory items produced similar results in the present study, we analyzed overall pain scores by averaging the ratings of the 15 descriptors. For the visual analogue scale, participants responded to a single item asking them to rate how severe the pain was during the task by marking a 100-mm line anchored with *no pain* on the left side and *worse pain possible* on the right side. For the pain intensity scale, participants responded to a single item asking them to rate how much pain they felt during the task using a six-point scale ranging from 0 (*no pain*) to 5 (*excruciating*). These three SF-MPQ scales, employing different reporting modalities, are often highly correlated. They can, however, account for unique variance in the experience of pain.[25] As this study served as an initial examination of optimism as a predictor of placebo analgesia, the prior literature did not provide sufficient evidence that these subscales would yield equivalent results. As such, we analyzed and report on each of these indexes in order to fully assess the pain experience across different reporting strategies.

Participants also responded to an expectation-manipulation check item. Specifically, on a 7-point Likert-type scale (with possible values ranging from 1 = *not at all* to 7 = *very much*), participants answered the question, "When the cream was put on your hand, did you expect it to protect you from the ice water?" This manipulation check item, created for this experiment, was based on items used previously to gauge the effectiveness of expectations manipulations.[11,14]

At the end of the experiment, all participants were thanked and debriefed.

Statistical Analysis

Hierarchical linear regression analyses were used to test the majority of our hypotheses. In these analyses, we included experimental condition (0= control, 1 = placebo) and dispositional optimism scores (standardized) on the first step of the regression model. On the second step of the regression model, we added in the Experimental Condition × Dispositional Optimism interaction term. When dichotomous data were analyzed, this same model set up was employed with a hierarchical logistic regression model. When interaction terms were significant, simple slope tests were conducted to clarify the nature of the interaction following the guidelines of Aiken and West[3] for one continuous and one dichotomous predictor variable. We used two simple slope tests to examine the relationship between optimism scores and pain reports in the conditions. Two additional simple slope tests were then computed by centering high (+1 *SD*) and low (−1 *SD*) on the optimism scale. This second set of simple slope tests determined if the pain reports of individuals high in dispositional optimism differed due to experimental condition and if the pain reports of individuals low in dispositional optimism differed due to experimental condition. Finally, Pearson correlations were used for correlational analyses.

Results

Exposure Time

Before analyzing pain reports, we examined the amount of time participants held their hand in the ice water. Of the 116 participants, 91 (78%) kept their hand in the ice water for the entire 120 second period. Because time in the water differed among participants, this variable could influence how the expectation manipulation and optimism scores relate to pain reports. For this reason, we first submitted participants' time in the ice water scores to our hierarchical linear regression analysis. The results of this analysis yielded no significant effects (all *p*s > .40); indicating that experimental condition and dispositional optimism did not independently or jointly predict time in the water. We also created a dichotomous variable on which participants who kept their hand in the ice water for the entire 120 seconds were coded as 1, whereas participants who pulled their hand out early were coded a 0. When scores on this dichotomous variable were submitted to our hierarchical logistic regression analysis, no significant effects emerged (all *p*s > .40). In summary, experimental condition and optimism did not relate to how long participants kept their hand in the ice water. Correlational analyses did indicate, however, that the length of time participants held their hand in the water was significantly and negatively correlated with scores on the SF-MPQ scales (Overall pain index $r = -.30$, pain intensity scale $r = -.37$, visual analogue scale $r = -.31$, all *p*s < .001). Because time in the water accounted for significant variance in pain ratings, we controlled for this variable in all subsequent analyses.

Expectation Manipulation Check

To determine if the expectation manipulation was successful, the data from the expectation manipulation-check item were entered into our hierarchical linear regression analysis. This regression revealed a significant effect of experimental condition, $\beta = .41$, $t(112) = 4.79$, $p = .00005$, indicating that participants in the placebo condition anticipated the hand cream to protect them from the pain of the cold pressor task more than participants in the control condition ($M = 3.40$, $SD = 1.97$ and $M = 1.87$, $SD = 1.32$, respectively). Importantly, optimism ($\beta = .01$, $p = .93$) and the Experimental Condition × Optimism interaction term ($\beta = -.03$, $p = .82$) were not significant predictors in this regression analysis.

Pain Reports

Overall pain index—To test the hypothesis that experimental condition and optimism interact in predicting pain, we submitted scores of the SF-MPQ overall pain index to our hierarchical linear regression analysis, again controlling for time in the water. In this regression, experimental condition ($\beta = -.12$, $p = .18$) and optimism ($\beta = -.11$, $p = .23$) did not independently predict pain ratings. However, the interaction between experimental condition and optimism proved to be a significant predictor, $\beta = -.31$, $t(111) = 2.28$, $p = .024$. A plot of the regression lines derived from this analysis are presented in the top panel of Figure 1 (top panel). Figure 1 presents scores on the pain indices (y-axis) as a function of high (+1 *SD*) and low (−1 *SD*) dispositional optimism on the x-axis and the condition variable is reflected by the two different lines. Simple slope tests examining the relationship between optimism scores and overall pain reports in the two conditions revealed that in the placebo condition, higher optimism was associated with lower pain ratings, $\beta = -.28$, $p = .018$. In the control condition, however, dispositional optimism was not associated with pain ratings, $\beta = .13$, $p = .34$. Further, when centered high on optimism, overall pain scores were lower in the placebo condition than in the control condition, $\beta = -.32$, $p = .01$. Overall pain ratings did not differ across conditions when the analysis was conducted by centering low on optimism, $\beta = .08$ $p = .54$.

Visual analogue scale—Analysis of the visual analogue scores yielded no independent effects due to experimental condition ($\beta = -.14$, $p = .11$) or optimism ($\beta = -.10$, $p = .27$).

Consistent with the findings on the overall pain index, the Experimental Condition × Optimism interaction was a significant predictor of visual analogue scores, β = −.30, t (111) = 2.23, p = .028 (see Figure 1, middle panel). Our first simple slope test revealed a significant negative relationship between optimism scores and visual analogue scores in the placebo condition, β = − .26, p = .024. A second simple slope test indicated that there was no corresponding association between optimism and visual analogue scores in the control condition, β = .13, p = .33. A third simple slope test revealed that for individuals high in optimism, visual analogue scores were lower in the placebo condition than in the control condition, β = −.34, p = .007. A final simple slope test indicated that visual analogue scores did not differ by condition for individuals scoring low in optimism, β = .06, p = .66.

Present pain intensity scale—Scores on the present pain intensity scale of the SF-MPQ were not predicted by the independent contribution of experimental condition (β = −.13, p = .15) or optimism (β = −.06, p = .51). Similar to the other two pain indices however, the Experimental Condition × Optimism interaction term did predict pain intensity scores, β = −.28, t (111) = 2.05, p = .04 (see Figure 1, bottom panel). A simple slope test revealed a marginal but non-significant relationship between optimism scores and pain intensity in the placebo condition, β = −.21, p = .07. There was also no association between optimism and pain intensity in the control condition, β = .15, p = .26. When we examined pain intensity scores among those high and low in optimism, we found that for individuals high in optimism, pain intensity was lower in the placebo condition than in the control condition, β = −.31, p = .01. For those lower in optimism, pain intensity scores did not differ due to experimental condition, β = .06 p = .62.

Blood Pressure and Heart Rate

Changes in systolic blood pressure, diastolic blood pressure, and heart rate were then submitted to our hierarchical regression analyses. Change scores on these three variables were created by subtracting scores obtained during the 10 minute resting baseline period from scores obtained during the cold pressor task. Analyses of these change scores yielded no significant effects (all ps > .10).

Discussion

Prior research on the placebo effect has found few individual-difference variables to predict placebo responding. The present results demonstrate that dispositional optimism can determine placebo responding to experimental pain. The expectation manipulation was successful and pain reports displayed the anticipated interaction between the expectation manipulation and optimism. Interestingly, we found no difference in pain reports between the placebo condition and the control condition without the inclusion of the optimism variable. This finding demonstrates the importance of considering individual-difference variables in placebo research. That is, without the addition of this variable we would have concluded that there was no placebo effect. Other studies have failed to uncover placebo expectancy effects,[17,38] and our finding suggests that a number of these failures in the literature were not really failures, but merely lacked the assessment of dispositional optimism. As such, researchers studying placebo analgesia should consider incorporating this variable into their research designs.

The present findings support the broader notion that personality variables alter placebo responding. An earlier wave of placebo research beginning in the 1950s looked for individual-difference variables that predict placebo responding.[7, 12, 16, 20] These studies focused primarily on identifying individuals who are likely to respond to placebo treatments—sometimes referred to as the “placebo-prone” personality. Taken in isolation, the results of the current study could be taken as evidence that optimism is a placebo-prone personality variable. Yet, a prior study

suggests that this is not the case. Specifically, Geers et al.[12] found that when given an expectation to feel an increase in negative symptoms, pessimism rather than optimism related to greater placebo responding. As such, optimism appears to relate to positive placebo responding, whereas pessimism relates to negative placebo responding. Taken together, these findings do not support the notion that optimistic individuals are placebo reactors. Rather, the data support an interactionist perspective in which individual-differences—such as dispositional optimism—and situational factors—such as the valence of the anticipated symptoms—jointly determine the effectiveness of a placebo.[13, 18]

One interesting direction for future research would be to explore how dispositional optimism increases placebo analgesia. There are many possible mechanisms by which this could occur. For example, it may be that optimists are more likely to cognitively elaborate on placebo expectations and this greater elaboration activates positive affect or reduces anxiety. Although the present study did not yield data directly supporting these or other mechanisms, it did provide evidence against one possible mechanism. Specifically, it could be theorized that optimism relates to placebo analgesia because optimists are more persuaded by positive placebo expectations than are pessimists. However, our expectation manipulation check data do not support this explanation. Specifically, optimism scores were not associated with responses to the expectation manipulation check item—suggesting that optimism did not alter how persuaded participants were by the manipulation.

In conducting this research, our theoretical position has been that optimism is a moderator rather than a mediator of placebo responding. Moderating variables are factors that influence the strength and/or direction of the relation between a predictor and a criterion variable, whereas mediating variables refer to the intermediary processes between a predictor and a criterion variable.[28] Our interpretation of optimism as a moderating variable is consistent with the prior studies in which high optimism has led to stronger responding to a positive placebo expectation, whereas low optimism led to stronger responding to a negative placebo expectation. Thus, we suggest that whereas variables such as the biased detection of symptoms and the elaboration on positive or negative feelings are mediators of placebo responding, optimism level is one factor that alters the strength and direction of placebo effects. That said, other possibilities do exist. For example, optimism may serve as *both* a moderator and a mediator of placebo analgesia.[28] This conceptual issue necessitates further investigation.

Another issue requiring attention is the independence of the optimism variable in predicting placebo analgesia. That is, dispositional optimism scales correlate with other individual-difference variables such as neuroticism, trait anxiety, locus of control, and self-mastery. Given this overlap in variance, it could be that one of these related constructs is at least partially responsible for the current findings.[34] That said, many studies find dispositional optimism to account for unique variance.[10, 37] As such, it seems likely that dispositional optimism will continue to predict placebo analgesia even when controlling for related constructs. Some support for this view comes from the research of Geers et al.[13] In this study, participants were given a placebo manipulation and both individual differences in optimism and social desirability were measured. Optimism, but not social desirability, predicted placebo responding. Although the data from that study and the data from the current study support continued interest in optimism and placebo analgesia, additional studies are needed to clarify the independent role of dispositional optimism in this domain.

As with any study, there are limitations that need to be acknowledged. Perhaps the most important limitation is that we only examined healthy college student participants. As this type of sample differs in numerous ways from clinical samples, one must be cautious in extrapolating from these findings to clinical settings. Also, because we used a laboratory pain task, it is likely that participants knew that the pain would not last long and this knowledge of

impending relief could be an important factor influencing our pattern of results. Consequently, it will be critical for future research to examine the combined influence of optimism and placebo analgesia on individuals with clinical pain. The current research design was also limited to one type of placebo treatment and to a single and relatively brief experimental pain task. Further, the cold pressor arrangement used here differs from other protocols employing a circulating ice bath and those which do not allow participants' hands to have direct contact with ice. As such, future research should be conducted to expand the types of placebo treatments, pain tasks, and even different variations of the cold pressor task to assess the generalizability of our findings. Studies of this kind will improve our understanding of the relationships between dispositional optimism, placebos, and pain.

Perspective

This study examined the possibility that individual differences can predict placebo analgesia. Participants were randomly assigned to receive either a placebo expectation or no expectation prior to a cold pressor task. Dispositional optimism was related to less cold pressor pain in the placebo condition as compared to the control condition.

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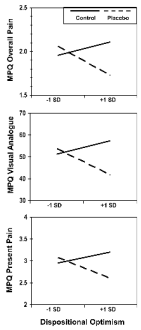

Figure 1.

Scores on the SF-MPQ overall pain index (top panel), ranging from 1 – 4, the SF-MPQ visual analogue scale (middle panel), ranging from 0–100, and the SF-MPQ present pain intensity scale (bottom panel), ranging from 0 – 5, as a function of experimental condition (control condition and placebo condition) and high (+1 *SD*) and low (−1 *SD*) dispositional optimism. Higher numbers on the SF-MPQ scales indicates greater pain.