Published in final edited form as:

J Behav Med. 2013 April ; 36(2): 165–174. doi:10.1007/s10865-012-9411-7.

Testing the relation between dispositional optimism and conditioned pain modulation: Does ethnicity matter?

Burel R. Goodin, Ph.D.¹, Tarek Kronfli, M.A.², Christopher D. King, Ph.D.¹, Toni L. Glover, M.S.N., A.R.N.P.^{1,3}, Kimberly Sibille, Ph.D.¹, and Roger B. Fillingim, Ph.D.¹

¹University of Florida College of Dentistry, Comprehensive Center for Pain Research, Gainesville, FL 32610, USA

²California School of Professional Psychology-San Francisco, Alliant International University, San Francisco, CA 94133, USA

³University of Florida College of Nursing, Gainesville, FL 32610, USA

Abstract

Greater dispositional optimism has been related to less severe pain; however, whether optimism is associated with endogenous pain modulation has not yet been examined. The beneficial effects of dispositional optimism often vary according to cultural dynamics. Thus, assessing optimism-pain relationships across different ethnic groups is warranted. This study sought to examine the association between optimism and conditioned pain modulation (CPM), and test whether this association differs according to ethnicity. Optimism and CPM were assessed in a sample of healthy, ethnically diverse young adults. CPM was determined by comparing pressure pain thresholds obtained before and during exposure to a cold pressor task. All participants completed a validated measure of dispositional optimism. Greater reported optimism was significantly associated with enhanced CPM, and the strength of this association did not vary according to individuals' ethnic background. These findings suggest that an optimistic disposition may potentiate endogenous pain inhibition.

Keywords

Dispositional optimism; Pain inhibition; Conditioned pain modulation; Ethnic differences

Introduction

Over recent decades, psychological and socio-cultural variables have garnered increasing prominence in biopsychosocial models addressing mechanisms of pain perception (Gatchel et al., 2007; Turk, 1996). Research to date has identified a number of important psychosocial variables (e.g., pain catastrophizing, gender, and culture/ethnicity) that appear to significantly impact the pain experience (Blyth et al., 2001; Pincus et al., 2002; Turk & Okifuji, 2001). However, the current literature is saturated with studies focused on identifying psychosocial risk factors for negative pain-related outcomes. Conversely, much less is known about positive psychosocial constructs (e.g., optimism, hopefulness, happiness) in relation to pain experience. One particular construct, dispositional optimism,

*Corresponding author: Tel.: +1-352-273-8934; fax: +1-352-273-6945. bgoodin1@ufl.edu (B. Goodin). Address for corresponding author: B. Goodin, University of Florida College of Dentistry, 1395 Center Drive, Dental Tower, Room D2-13, Gainesville, FL 32610.

There are no conflicts of interest, or any financial interests, to report with regard to this work for any of the authors.

has been shown to possess widespread health promoting effects (Allison et al., 2003; Byrnes et al., 1998; Raikkonen et al., 1999; Scheier et al., 1999) and accordingly, there has been growing speculation that dispositional optimism could influence the course and experience of pain. Recently, the associations of optimism with various pain outcomes have been addressed (Geers et al., 2010; Geers et al., 2008; Morton et al., 2009). In a laboratory setting using experimental pain testing, Geers and colleagues demonstrated that greater dispositional optimism was not only associated with decreased pain sensitivity, distress, and cardiovascular reactivity (Geers et al., 2008), but also enhanced placebo analgesia (Geers et al., 2010; Morton et al., 2009). These findings lend support to the beneficial contributions of optimism to the pain experience, yet the mechanisms underlying how optimism might relate to pain remain unknown.

Enhanced endogenous pain-inhibitory processes are one potential mechanism that may account for decreased pain sensitivity among individuals who report greater dispositional optimism. The positive outcome expectancies and adaptive coping strategies that characterize an optimistic disposition (Scheier & Carver, 1985; Scheier et al., 1986) may diminish pain experiences by enhancing the efficacy of endogenous pain-inhibitory pathways. However, no study to date has tested the relationship between optimism and endogenous pain-inhibitory function. Indirect support for this hypothesis comes from a previous and separate study whereby catastrophizing, a maladaptive pain coping strategy with pessimistic features, was shown to be associated with diminished efficacy of endogenous pain-inhibitory processes (Goodin et al., 2009). Conversely, the opposite also seems plausible, that optimism may be associated with enhanced endogenous-pain inhibitory processes. Underscoring this possibility, a recent fMRI study revealed that greater dispositional optimism and induced optimistic bias were positively correlated with brain activity in cortical regions involved in endogenous pain-inhibitory networks (Sharot et al., 2007). On balance, it is reasonable that enhancements in descending pain-inhibitory systems important in pain processing (Millan, 2002) may underlie some of the beneficial effects of optimism on pain outcomes.

The measurement of conditioned pain modulation (CPM), or DNIC-like effect in humans (Pud et al., 2009) provides a model for studying endogenously-mediated pain modulation as a putative mechanism underlying the influence of dispositional optimism on pain responses. One method for assessing CPM, a measure of descending pain inhibition, is the use of a heterotopic pain conditioning paradigm (Price & McHaffie, 1988), such that the pain produced by a painful test-stimulus is inhibited by the pain produced from the application of a second painful conditioning stimulus. Using this approach, CPM is assessed by measuring responses to a phasic pain stimulus before and during application of a tonic pain stimulus applied to a distant body site. The magnitude of CPM is calculated as the decrease in phasic pain observed during concurrent administration of the tonic conditioning stimulus. Studies that have examined the relationship between attention and CPM on pain outcomes have shown that the “pain inhibiting pain” phenomenon attributable to CPM is not dependent upon distraction (Lautenbacher et al., 2007; Moont et al., 2010). The analgesic effect of CPM in humans is thought to be produced by supraspinally-generated inhibition of wide dynamic range (Cadden, 1993) and nociceptive-specific (Hu, 1990) neurons. The clinical relevance of experimental pain procedures involving CPM has been previously demonstrated (Edwards et al., 2003; Yarnitsky, 2010).

When examining the relationship between dispositional optimism and endogenous pain inhibition (i.e. CPM), individuals’ ethnic background should be considered. Considerable evidence now suggests that the experience of both clinical and experimental pain differs among ethnic groups (Edwards et al., 2001 for review). More specifically, in a series of laboratory-based studies conducted by Campbell and colleagues, African Americans were

shown to be more pain sensitive to multiple modalities of experimental noxious stimulation (e.g., heat, cold, ischemic pain) (Campbell et al., 2005), possess lower thresholds for eliciting the nociceptive flexion reflex (Campbell et al., 2008A), and produce less robust CPM compared to their non-Hispanic white counterparts (Campbell et al., 2008B). Whether CPM differs across ethnic groups other than non-Hispanic whites and African Americans remains to be determined. Ethnicity and culture have also been discussed as potential variables influencing levels of dispositional optimism (Lee & Seligman, 1997; Lai & Yue, 2000). However, evidence thus far is mixed with some studies finding ethnic and cultural differences in levels of optimism (Chang, 1996; Chang et al., 2010), while others have not (Ji et al., 2004). When ethnic and cultural differences in optimism emerged (Chang, 1996; Chang et al., 2010), it was generally the case that non-Hispanic whites reported greater levels of optimism compared to indigenous Asian and Asian Americans. At this time, relatively little research has examined differences in optimism between non-Hispanic whites and African Americans. Taken together, there appears to be sufficient evidence to suggest that the association of dispositional optimism with CPM may differ as a function of individuals' ethnic identity.

Along this vein, the present research addressed the inter-relationships among dispositional optimism, self-reported ethnic identity, and CPM. Using laboratory pain testing procedures in healthy young adults, we examined the following questions: (1) Are there significant ethnic differences in dispositional optimism and CPM? (2) Is dispositional optimism positively associated with CPM? (3) Does the strength of the relationship between dispositional optimism and CPM meaningfully differ according to individuals' self-identified ethnic affiliation (i.e., effect moderation)? For study question (2), participants' ethnicity, along with sex, depressive ratings and pain catastrophizing, was included as a statistical control to examine the unique relationship between dispositional optimism and CPM. The rationale for inclusion of these statistical controls is as follows: (A) significant sex and ethnic differences have previously been reported for dispositional optimism (Chang, 1996; Giltay et al., 2004) and CPM (Campbell et al., 2008B). (B) Both depressive symptoms and pain catastrophizing have previously been shown to be associated with disruption of the CPM response (de Souza et al., 2009; Goodin et al., 2009). Therefore, not statistically controlling for these variables could potentially overshadow any unique association of dispositional optimism with CPM.

METHODS

Participants

For recruitment purposes, study flyers were posted throughout the campus of an urban mid-Atlantic university. Individuals interested in study participation initially completed a web-based screening form; the web-site address was provided on the study flyer. Eligible participants met the following criteria: (a) between the ages of 18 and 45 years; (b) no ongoing chronic pain problems; (c) not diagnosed with hypertension or taking blood pressure medications; (d) no circulatory disorders; (e) no history of cardiac events; (f) not pregnant; (g) no history of metabolic disease or neuropathy; (h) not currently using prescription medications including analgesics, tranquilizers, antidepressants, or other centrally acting agents; and (i) no mental health disorders (e.g., depression). Following completion of the web-based screening, eligible participants were contacted via electronic mail to schedule an appointment. Participants were instructed to refrain from using alcohol, nicotine products, and non-prescription medications on the day of participation. In addition, participants were asked to abstain from caffeinated beverages and vigorous exercise for at least two hours before study participation. A total of 155 healthy college students from four ethnic groups (86 Caucasian Americans, 35 Asian Americans, 28 African Americans, and 6 Hispanic American) participated in the current study. The six Hispanic participants were not

included in data analyses; these individuals did not significantly differ from any other ethnic group on optimism or CPM ($p's > 0.10$). The final sample was 149 individuals (Caucasian Americans, Asian Americans, and African Americans). Within the final sample, 78 (52%) participants were female and the mean age was 19.9 years, $SD = 2.9$ (range = 18 to 38 years).

Procedures

Data were collected as part of a multifactorial study examining the ethnic and psychophysiological correlates of experimentally-induced acute pain sensations (Goodin, 2009). Participants completed a single 90-minute laboratory session. Demographic information and psychosocial questionnaires were completed at the beginning of the session prior to quantitative sensory testing. Participants were matched by sex with an experimenter for completion of quantitative sensory testing. All study procedures were approved by the university's Institutional Review Board, and informed consent was obtained before the initiation of study procedures. Participants were compensated for their participation.

Quantitative Sensory Testing

Mechanical pain induction—Baseline pressure pain threshold (PPT) was assessed at two anatomic locations on participants' left-side using a pressure algometer (Somedic AB, Horby, Sweden): 1) dorsal forearm (distal third), and 2) the ipsilateral trapezius. To assess PPT, an algometer (circular, rubber-tipped contact surface of 1.0 cm^2) was applied three times at each location, which was counter-balanced. The pressure algometer has previously been established as a reliable and valid assessment of normal muscle tenderness in non-patient samples (Cathcart & Pritchard, 2006; Ohrbach & Gale, 1989). Participants indicated when the increasing pressure stimulation first became painful. PPTs were measured in kilopascals (kPa).

CPM trials—CPM was assessed using a heterotopic noxious conditioning stimulation paradigm (Price & McHaffie, 1988). Following baseline PPT determination (test stimulus), participants underwent a series of four cold pressor tasks (CPT; conditioning stimulus) that consisted of immersing the right hand, up to the wrist, for one minute in a circulating water bath (Neslab, RTE-111, Portsmouth, NH) maintained at 4°C . Participants were told they could remove their hand from the water at any time; however, they were also provided the following instruction, "please keep your hand immersed in the water bath for the entire minute or we may not be able to use your data". None of the participants pre-maturely removed their hand from the water bath prior to the allotted one minute for any of the four cold water immersions. Twenty seconds after cold pressor immersion, the algometer was used to deliver noxious mechanical stimulation to either the left dorsal forearm (two trials) or the left trapezius (two trials); the site order was randomized. Participants again indicated when the increasing pressure stimulation first became painful. Each participant completed four CPM trials, with a two-minute rest period between each trial.

CPM calculation—A total of 10 PPT tests were completed (5 forearm, 5 trapezius). For each anatomic location, PPT was assessed three times during baseline testing and twice more during concurrent exposure to the CPT. Intra-class coefficients (ICC) were calculated for PPT at baseline and during cold water immersion for each anatomic location. This was done to determine the reliability of the algometer across multiple PPT tests. ICCs of .75 or above are generally considered as excellent (Streiner, 1995). The ICCs for all PPT tests were .80 or above in the current study. Given this excellent reliability, repeated PPT measurements were averaged within each of the two anatomic locations for baseline and CPT trials. CPM was calculated using delta change scores, whereby baseline PPTs were

subtracted from the cold water immersion-associated thresholds. CPM was computed separately for the forearm and trapezius.

Psychosocial Questionnaires

Life Orientation Test-Revised (LOT-R)—The LOT-R (Scheier & Carver, 1985) assesses generalized positive outcome expectancies and contains 6 self report items (plus 4 filler items), each rated on a 5-point scale ranging from 0 (strongly disagree) to 4 (strongly agree). To calculate dispositional optimism scores, the 3 negatively worded items (e.g., I hardly ever expect things to go my way) were reversed scored and averaged together with the 3 positively worded items (e.g., I am always optimistic about my future) to create a summary optimism score. Substantial research supports the reliability and validity of the LOT-R instrument (Scheier et al., 1994), and the internal consistency of the LOT-R in study 1 was good ($\alpha = 0.80$).

Pain Catastrophizing Scale (PCS)—The Pain Catastrophizing Scale (Sullivan et al., 1995) is a 13-item scale that assesses catastrophic thinking in response to pain. The PCS assesses catastrophic pain-related cognitive-emotional processes by asking participants to recall their experiences during a past occurrence of pain. In the current study, as is typically done in experimental pain studies, the PCS was administered prior to the initiation of the laboratory pain tasks and was considered an assessment of individuals' tendency to engage in pain-related catastrophizing. The PCS total score, calculated by summing the 13 item responses, provides a good index of the catastrophizing construct through the inclusion of the highly correlated subscales of helplessness, rumination, and magnification. Higher scores on the PCS are indicative of greater pain-related catastrophizing. The internal consistency of the PCS in study 1 was very good ($\alpha = 0.86$).

Beck Depression Inventory (BDI)—The BDI is a 21-item self-report measure designed to assess DSM-IV depressive symptomatology in adolescents and adults (Beck et al., 1961). Respondents are asked to rate each of the depressive symptoms, ranging from 0 (not present) to 3 (severe), in terms of how they have been feeling during the past two weeks. The BDI is designed to provide a single overall score that can range from 0 to 63, with higher scores representing greater depressive symptomatology. The BDI has well-established psychometric properties (Beck et al., 1988) and the internal consistency of the BDI in study 1 was good ($\alpha = 0.81$).

Data Reduction and Analysis

Descriptive statistics were computed and Pearson correlation coefficients were determined for continuously-measured variables. The presence of CPM effects was examined using pairwise t-tests. The significance of ethnic group differences in dispositional optimism and CPM was determined by analysis of variance (ANOVA). Post hoc analyses, using Tukey's honestly significant differences, were also conducted for pair-wise contrasts across ethnic groups. A multiple regression analysis was completed to examine the unique association of dispositional optimism with CPM controlling for appropriate covariates. Further, a hierarchical multiple regression analysis was performed to examine whether the relationship between dispositional optimism and CPM was significantly moderated by individuals' ethnic background. Per the recommendations of Aiken and West (1991) for conducting tests of moderation with a multinomial variable (ethnicity), optimism scores were centered by subtracting the mean from each value, and a cross-product interaction term was created by multiplying centered optimism with a series of dummy-coded (0/1) ethnicity variables. Ethnicity was dummy-coded such that the Caucasian American cohort was the referent group for comparison. In an adjusted analysis, control variables were entered into the model

(Step 1) before entering the optimism and dummy-coded ethnicity main effects (Step 2) followed by the interaction terms (Step 3).

RESULTS

Zero-Order Correlations and Ethnic Differences

Zero-order correlations are presented in Table 1. Consistent with previous findings, sex was significantly correlated with CPM, such that men demonstrated greater pain inhibition (i.e., greater increase in PPT during cold immersion) than women. Dispositional optimism was significantly and inversely correlated with depressive rating ($p < 0.01$) and pain catastrophizing ($p < 0.01$). Dispositional optimism was not significantly correlated with CPM ($p > 0.05$) in this unadjusted univariate analysis.

Means and standard deviations for the psychosocial measures: LOT-R, PCS, and BDI were categorized according to ethnic background and are presented in Table 2. African Americans, Caucasian Americans, and Asian Americans reported comparable levels of dispositional optimism ($F_{2,146} = 2.30, p = 0.11$) and pain catastrophizing ($F_{2,146} = 1.21, p = 0.30$). A significant ethnic difference was demonstrated for the BDI ($F_{2,146} = 4.86, p < 0.01$); specifically, Asian Americans reported greater depressive symptoms than their Caucasian American counterparts ($p < 0.01$). Despite unequal sample size across ethnic groups, LOT-R, PCS, and BDI were all found to be approximately normally distributed with homogenous variances as indicated by Shapiro-Wilk statistics (p 's > 0.05) and Levene's test (p 's > 0.05), respectively. These findings suggest that the statistical assumptions for the use of ANOVA to assess ethnic differences in the study variables were not violated.

CPM

Pairwise t-tests revealed significant CPM effects on PPT for both the forearm ($t_{147} = 4.97, p < 0.001$) and trapezius ($t_{147} = 6.29, p < 0.001$) testing sites, such that the PPTs obtained during concurrent application of cold water pain were significantly greater than baseline PPTs. Although the strength of CPM was found to be greater at the trapezius testing site than at the forearm ($p = 0.02$), the site specific CPM calculations for trapezius and forearm were averaged together to obtain an overall CPM value that was used as the criterion variable in all subsequent analyses. Additional analyses of ethnic differences revealed comparable baseline PPT at the forearm ($F_{2,146} = .08, p = 0.92$) and trapezius sites ($F_{2,146} = .33, p = 0.72$), in addition to a comparable overall CPM response ($F_{2,145} = .20, p = 0.82$) in African Americans, Caucasian Americans, and Asian Americans as reported in Table 3. Neither Shapiro-Wilk statistics nor Levene's test were violated (p 's > 0.05) during the test of ethnic differences in PPT and CPM.

Multiple Regressions

An adjusted multiple regression analysis predicted a small but significant amount of the total variance in overall CPM response ($R^2 = 0.08, p = 0.046, f^2 = 0.09$; small to medium effect size) (Table 4). In particular, this analysis revealed a significant and positive relationship between dispositional optimism and CPM ($\beta = 0.19, p = 0.04, f^2 = 0.04$; small effect size), which suggests that greater reported optimism was associated with enhanced endogenous pain inhibition.

In a subsequent adjusted analysis, ethnicity was examined as a moderator of the dispositional optimism-CPM relationship (Table 5). This analysis was completed to determine whether the strength and/or direction of the association between optimism and CPM differed according to participants' ethnic background. Results of a hierarchical multiple regression analysis failed to demonstrate any significant moderation effects for

ethnicity ($R^2 \Delta = 0.006$, $p = 0.64$); the relationship between dispositional optimism and CPM for Caucasian Americans was not significantly different from the optimism-CPM relationships of Asian Americans ($p = 0.79$) or African Americans ($p = 0.42$). Taken together, these results suggest that the overall relationship between dispositional optimism and CPM across the entire sample was positive and significant, and did not differ as a function of ethnicity.

DISCUSSION

The primary aims of the present study were 1) to determine whether there were significant ethnic differences in dispositional optimism and CPM, 2) to examine the unique relationship between dispositional optimism and CPM while controlling for other variables known to account for significant variance in CPM response (e.g. sex, pain catastrophizing), and 3) to determine whether the strength of the optimism-CPM relationship varied as a function of ethnicity (i.e., effect moderation). Contrary to previous reports, the current study did not reveal significant ethnic differences in dispositional optimism or CPM (Aim 1). These findings suggest that in the current sample of healthy college students, Caucasian Americans, Asian Americans, and African Americans possessed seemingly comparable positive expectations for the future and pain inhibitory capabilities. Consistent with recent studies that have demonstrated associations between dispositional optimism and other pain-related outcomes (Geer et al., 2010; Geers et al., 2008; Morton et al., 2009; Costello et al., 2002), optimism was significantly and positively related with CPM in this study (Aim 2). It should be noted that the unadjusted analysis (i.e., Pearson correlation) did not reveal a significant relationship between dispositional optimism and CPM. It was not until this relationship was adjusted for participants' sex, ethnicity, depressive symptoms, and pain catastrophizing (i.e., multiple regression) that it became significant. It appears that statistical adjustment for the confounding effects of these other study variables helped to provide an undistorted estimate of the relationship between dispositional optimism and CPM (MacKinnon et al., 2000), which became stronger relative to the unadjusted analysis. To our knowledge, this study is the first to suggest that greater dispositional optimism may be related with enhanced endogenous pain modulation, particularly paradigms related to CPM. Of particular interest is that the optimism-CPM relationship found in the present study did not significantly vary as a function of ethnic background (i.e., no effect moderation; Aim 3), which suggests that this relationship is potentially of similar magnitude across a wide range of people.

These findings provide preliminary and indirect evidence suggesting that the less severe pain reported by individuals with a greater optimistic disposition (Costello et al., 2002) may be related to enhancements in the endogenous inhibition of pain (Edwards et al., 2003; Goodin et al., 2009). From this hypothesis, two questions arise: 1) what exactly is dispositional optimism and, 2) what might be the mechanisms linking dispositional optimism to CPM and pain severity? The construct of dispositional optimism, or generalized outcome expectancies, was defined by Scheier and Carver (1985) on the basis of their broader behavioral self-regulation model (Carver & Scheier, 1981). Accordingly, individuals high in optimism are people who expect positive outcomes. As a consequence, they anticipate being able to cope effectively with everyday threats and challenge. Conversely, less optimistic individuals (i.e., pessimists) are people who expect negative outcomes and do not anticipate being able to cope successfully (Scheier et al., 2001). Much of the research on the relationship between optimism and health has drawn its conclusions by contrasting optimists to pessimists. Based on these comparisons, it appears that optimists use more effective coping strategies than pessimists when confronted by threat or challenge (Long & Sangster, 1993; Scheier et al. 1986). Indeed, a recent meta-analysis confirmed that

coping differences mediate the relationship between optimism and health (Solberg Nes & Segerstrom, 2006).

It is noteworthy that in the current study, dispositional optimism was significantly and inversely correlated with pain catastrophizing, a maladaptive coping strategy that has previously been shown to be associated with diminished CPM responses (Goodin et al., 2009). Although catastrophizing was negatively, but not significantly, associated with CPM in this study, we speculate that the presence and/or absence of adaptive versus maladaptive coping strategies may be a potential mechanism linking optimism and CPM. At this time, the neurophysiology of CPM in humans has not been completely characterized. Nonetheless, animal studies have described an inhibitory bulbo-spinal loop (Villanueva & Le Bars, 1995) and a recent fMRI study of CPM effects in healthy adults and patients with irritable bowel syndrome suggested that a network of subcortical and cortical structures, including the amygdala, anterior cingulate cortex, insula, periaqueductal gray, and prefrontal cortex, might be involved (Piche et al., 2009; Wilder-Smith et al., 2004). Moreover, additional developments in functional neuroimaging studies have shown that many of the cortical regions thought to be relevant to CPM effects are also implicated in the generation of optimistic expectations (Sharot et al., 2007), and in the processes of adaptive coping that characterize optimism (Edwards et al., 2009). For instance, the experimental induction of optimistic bias and the use of adaptive pain coping strategies (e.g., positive reinterpretation of pain-related sensations, cognitive restructuring, and making positive self-statements) have both been associated with reduced subjective perceptions of pain, with greater activation of regions in the prefrontal cortex and anterior cingulate, and corresponding attenuations in activation of key pain-processing areas such as the insular and secondary somatosensory cortices (Sharot et al., 2007; Wiech et al., 2006; Wiech et al., 2008). Thus, dispositional optimism and its accompanying cognitive processes such as adaptive pain coping strategies appear to be associated with the engagement of many of the cortical regions involved in top-down modulation of pain processing. Altogether, these findings suggest the possibility that dispositional optimism may directly or indirectly interact with the CNS processing of noxious stimuli to affect CPM and the perception of pain. Further research addressing pain coping strategies, and their cerebral underpinnings, as mechanisms underlying the association between dispositional optimism and pain-inhibitory processes related to CPM is needed.

CPM is now known to be, at least partially, opioid-dependent (Sprenger et al., 2011; Willer et al., 1990), and some indirect evidence links dispositional optimism specifically with the function of exogenous and endogenous opioid pain-control systems. Dispositional optimism is well supported for its relationships with individuals' expectations for the future and the use of more active/adaptive coping strategies (Scheier & Carver, 1985; Scheier et al., 1986). In turn, expectation-induced placebo analgesia was found to be associated with marked activation of mu-opioid receptor mediated neurotransmission in many brain regions including the prefrontal cortex and amygdala (Wager et al., 2007; Zubieta et al., 2005), and placebo analgesia was most potent and reproducible for individuals with greater dispositional optimism (Geers et al., 2010; Morton et al., 2009). Furthermore, adaptive pain coping strategies have also been shown to be associated with activation of opioid-mediated endogenous pain-inhibitory systems (Bandura et al., 1987). Lastly, greater dispositional optimism has been shown to be a significant moderator of the relationship between pain and daily opioid medication use in adolescents with sickle cell disease (Pence et al., 2007), suggesting that the more optimistic adolescents were better able to match their opioid use to their pain severity. On balance, these studies hint at the possibility that the current study's finding of an association between greater dispositional optimism and enhanced CPM may be related to the facilitation of underlying opioid-dependent mechanisms.

Although this study provides new information regarding the relationship between dispositional optimism and CPM, it is not without limitations. The lack of significant ethnic differences in dispositional optimism and CPM demonstrated in the present study is not consistent with what has been reported by previous research (Campbell et al., 2008B; Chang, 1996; Chang et al., 2010). This lack of significant ethnic differences may be attributable, at least in part, to certain factors related to the composition of the study sample. For instance, as the sample was drawn from a group of college students willing to complete experimental pain testing for compensation, this presents a potential sampling bias. Additionally, the inclusion of a young and healthy sample of Caucasian, Asian, and African Americans may limit the generalizability of this study's findings to clinical populations. Given that dispositional optimism and CPM are reportedly dampened and disrupted in clinical pain cohorts (Garafalo, 2000; King et al., 2009), the associations among dispositional optimism, CPM, and pain responses may well be less robust (or non-existent) in clinical populations than was found in our non-clinical sample. The fact that these were college students likely reduces socioeconomic differences that have been shown to be prevalent across and within ethnic groups. Additional research, incorporating a wider range of individuals from varied socioeconomic and educational backgrounds will be useful to verify whether the strength of the optimism-CPM relationship found in this study indeed remains consistent across different ethnic groups. Consideration of socioeconomic factors is important because they have been reported to exert strong influences of individuals' optimistic/pessimistic expectations for the future (Heinonen et al., 2006) and the self-report of pain (Latza et al., 2000), especially among individuals faced with chronic pain (Fuentes et al., 2007).

In conclusion, this study extends prior research suggesting the potentially important role of personality characteristics in shaping CNS pain processing. Further studies that examine potential mechanisms (e.g., endogenous opioids such as β -endorphin) underlying the relationship between greater dispositional optimism and enhanced CPM outcomes are needed. Whether psychological treatments for pain that attempt to amplify individuals' optimistic outlooks on life have effects through biological mechanisms such as alteration of descending pain-modulatory pathways is not yet known. Future research addressing this possibility may lend further support to the primary role of personality characteristics in the modulation of central pain processing and pain outcomes. Additionally, because the relationship between optimism and CPM was significant yet small, future studies should examine other centrally-mediated pain processing mechanisms that may partially account for the relationship between dispositional optimism and pain responses. Temporal summation, a frequently used index of central pain facilitation, may be one such mechanism. Although the hypothesis has not yet been tested to date, greater dispositional optimism may be concurrently associated with enhanced pain-inhibitory and diminished pain-facilitatory processes reflected by temporal summation (Staud et al., 2003), which may collectively mitigate pain processing and result in better pain outcomes.

Acknowledgments

This work was supported with funds from the Graduate Student Association at the University of Maryland, Baltimore County (B.R.G.) and by National Institutes of Health training grant T32NS045551-06 (B.R.G.).

References

- Aiken, L.S.; West, S.G. Multiple Regression: Testing and interpreting interactions. Newbury Park, CA: Sage; 1991.
- Allison PJ, Guichard C, Fung K, Gilain L. Dispositional optimism predicts survival status 1 year after diagnosis in head and neck cancer patients. *Journal of Clinical Oncology*. 2003; 21:543–548. [PubMed: 12560447]

- Bandura A, O'Leary A, Taylor CB, Gauthier J, Gossard D. Perceived self-efficacy and pain control: opioid and nonopioid mechanisms. *Journal of Personality and Social Psychology*. 1987; 53:563–571. [PubMed: 2821217]
- Beck AT, Steer RA, Garbin MG. Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*. 1988; 8:77–100.
- Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Archives of General Psychiatry*. 1961; 4:561–571. [PubMed: 13688369]
- Blyth FM, March LM, Brnabic AJN, Jorm LR, Williamson M, Cousins MJ. Chronic pain in Australia: a prevalence study. *Pain*. 2001; 89:127–134. [PubMed: 11166468]
- Byrnes DM, Antoni MH, Goodkin K, Efantis-Potter J, Asthana T, Simon J, et al. Stressful events, pessimism, natural killer cell cytotoxicity, and cytotoxic/suppressor T cells in HIV+ black women at risk for cervical cancer. *Psychosomatic Medicine*. 1998; 60:714–722. [PubMed: 9847030]
- Cadden SW. The ability of inhibitory controls to 'switch-off' activity in dorsal horn convergent neurones in the rat. *Brain Research*. 1993; 628:65–71. [PubMed: 8313171]
- Campbell CM, Edwards RR, Fillingim RB. Ethnic differences in responses to multiple experimental pain stimuli. *Pain*. 2005; 113:20–26. [PubMed: 15621360]
- Campbell CM, France CR, Robinson ME, Logan HL, Geffken GR, Fillingim RB. Ethnic differences in the nociceptive flexion reflex (NFR). *Pain*. 2008A; 134:91–96. [PubMed: 17482362]
- Campbell CM, France CR, Robinson ME, Logan HL, Geffken GR, Fillingim RB. Ethnic differences in diffuse noxious inhibitory controls. *Journal of Pain*. 2008B; 9:759–766. [PubMed: 18482870]
- Carver, CS.; Scheier, MF. *Attention and Self-Regulation: A control-theory approach to human behavior*. New York, NY: Springer-Verlag; 1981.
- Cathcart S, Pritchard D. Reliability of pain threshold measurement in young adults. *Journal of Headache and Pain*. 2006; 7:21–26. [PubMed: 16440140]
- Chang EC. Cultural differences in optimism, pessimism, and coping: Predictors of subsequent adjustment in Asian American and Caucasian American college students. *Journal of Counseling Psychology*. 1996; 43:113–123.
- Chang EC, Sanna LJ, Kim JM, Srivastava K. Optimistic and pessimistic bias in European Americans and Asian Americans: A preliminary look at distinguishing between predictions for physical and psychological health outcomes. *Journal of Cross-Cultural Psychology*. 2010; 41:465–470.
- Costello NL, Bradgon EE, Light KC, Sigurdsson A, Bunting S, Grewen K, et al. Temporomandibular disorder and optimism: Relationships to ischemic pain sensitivity and interleukin-6. *Pain*. 2002; 100:99–110. [PubMed: 12435463]
- de Souza JB, Potvin S, Goffaux P, Charest J, Marchand S. The deficit of pain inhibition in fibromyalgia is more pronounced in patients with comorbid depressive symptoms. *Clinical Journal of Pain*. 2009; 25:123–127. [PubMed: 19333157]
- Edwards CL, Fillingim RB, Keefe F. Race, ethnicity and pain. *Pain*. 2001; 94:133–137. [PubMed: 11690726]
- Edwards RR, Campbell C, Jamison RN, Wiech K. The neurobiological underpinnings of coping with pain. *Current Directions in Psychological Science*. 2009; 18:237–241.
- Edwards RR, Ness TJ, Weigent DA, Fillingim RB. Individual differences in diffuse noxious inhibitory controls (DNIC): association with clinical variables. *Pain*. 2003; 106:427–437. [PubMed: 14659526]
- Fuentes M, Hart-Johnson T, Green CR. The association among neighborhood socioeconomic status, race and chronic pain in black and white older adults. *Journal of the National Medical Association*. 2007; 99:1160–1169. [PubMed: 17987920]
- Garafolo, JP. Perceived optimism and chronic pain. In: Gatchel, RJ.; Weisberg, JN., editors. *Personality characteristics of patients with pain*. Washington, DC: American Psychological Association; 2000. p. 203–217.
- Gatchel RJ, Peng YB, Peters ML, Fuchs PN, Turk DC. The biopsychosocial approach to chronic pain: Scientific advances and future directions. *Psychological Bulletin*. 2007; 133:581–624. [PubMed: 17592957]
- Geers AL, Wellman JA, Fowler SL, Helfer SG, France CR. Dispositional optimism predicts placebo analgesia. *Journal of Pain*. 2010; 11:1165–1171. [PubMed: 20627818]

- Geers AL, Wellman JA, Helfer SG, Fowler SL, France CR. Dispositional optimism and thoughts of well-being determine sensitivity to an experimental pain task. *Annals of Behavioral Medicine*. 2008; 36:304–313. [PubMed: 19067097]
- Giltay EJ, Geleijnse JM, Zitman FG, Hoekstra T, Schouten EG. Dispositional optimism and all-cause and cardiovascular mortality in a prospective cohort of elderly Dutch men and women. *Archives of General Psychiatry*. 2004; 61:1126–1135. [PubMed: 15520360]
- Goodin, BR. PhD dissertation. United States – Maryland: University of Maryland, Baltimore County; 2009. A biopsychosocial explanation of an experimental pain outcome. Retrieved July 12, 2011, from Dissertations & Theses: Full Text (Publication No. AAT 3389006)
- Goodin BR, McGuire L, Allshouse M, Stapleton L, Haythornthwaite JA, Burns N, et al. Associations between catastrophizing and endogenous pain-inhibitory processes: Sex differences. *Journal of Pain*. 2009; 10:180–190. [PubMed: 19010738]
- Heinonen K, Raikkonen K, Matthews KA, Scheier MF, Raitakari OT, Pulkki L, et al. Socioeconomic status in childhood and adulthood: Associations with dispositional optimism and pessimism over a 21-year follow up. *Journal of Personality*. 2006; 74:1111–1126. [PubMed: 16787430]
- Hu JW. Response properties of nociceptive and non-nociceptive neurons in the rat's trigeminal subnucleus caudalis (medullary dorsal horn) related to cutaneous and deep craniofacial afferent stimulation and modulation by diffuse noxious inhibitory controls. *Pain*. 1990; 41:331–345. [PubMed: 2388770]
- Ji L, Zhang Z, Osborne E, Guan Y. Optimism across cultures: In response to the severe acute respiratory syndrome outbreak. *Asian Journal of Social Psychology*. 2004; 7:25–34.
- King CD, Wong F, Currie T, Mauderli AP, Fillingim RB, Riley JL III. Deficiency in endogenous modulation of prolonged heat pain in patients with irritable bowel syndrome and temporomandibular disorder. *Pain*. 2009; 143:172–178. [PubMed: 19278784]
- Lai JCL, Yue X. Measuring optimism in Hong Kong and mainland Chinese with the revised life orientation test. *Personality and Individual Differences*. 2000; 28:781–796.
- Latz U, Kohlmann T, Deck R, Raspe H. Influence of occupational factors on the relation between socioeconomic status and self-reported back pain in a population-based sample of German adults with back pain. *Spine*. 2000; 25:1390–1397. [PubMed: 10828921]
- Lautenbacher S, Prager M, Rollman GB. Pain additivity, diffuse noxious inhibitory controls, and attention: a functional measurement analysis. *Somatosensory and Motor Research*. 2007; 24:189–201. [PubMed: 18097992]
- Lee YT, Seligman MEP. Are Americans more optimistic than the Chinese? *Personality and Social Psychology Bulletin*. 1997; 23:32–40.
- Long BC, Sangster JJ. Dispositional optimism/pessimism and coping strategies: Predictors of psychosocial adjustment of rheumatoid and osteoarthritis patients. *Journal of Applied Social Psychology*. 1993; 23:1069–1091.
- MacKinnon DP, Krull JL, Lockwood CM. Equivalence of the mediation, confounding, and suppression effect. *Prevention Science*. 2000; 1:173–181. [PubMed: 11523746]
- Millan MJ. Descending control of pain. *Progress in Neurobiology*. 2002; 66:355–474. [PubMed: 12034378]
- Moont R, Pud D, Sprecher E, Sharvit G, Yarnitsky D. “Pain inhibits pain” mechanisms: Is pain modulation simply due to distraction? *Pain*. 2010; 150:113–120. [PubMed: 20493631]
- Morton DL, Watson A, El-Dereby W, Jones AKP. Reproducibility of placebo analgesia: Effect of dispositional optimism. *Pain*. 2009; 146:194–198. [PubMed: 19692178]
- Ohrbach R, Gale EN. Pressure pain thresholds in normal muscles: reliability, measurement effects, and topographic differences. *Pain*. 1989; 37:257–263. [PubMed: 2755707]
- Pence L, Valrie CR, Gil KM, Redding-Lallinger R, Daeschner C. Optimism predicting daily pain medication use in adolescents with sickle cell disease. *Journal of Pain and Symptom Management*. 2007; 33:302–309. [PubMed: 17349499]
- Piche M, Arsenault M, Rainville P. Cerebral and cerebrospinal processes underlying counterirritation analgesia. *Journal of Neuroscience*. 2009; 29:14236–14246. [PubMed: 19906971]

- Pincus T, Burton KA, Vogel S, Field AP. A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. *Spine*. 2002; 27:E109–E120. [PubMed: 11880847]
- Popescu A, LeResche L, Truelove EL, Drangsholt MT. Gender differences in pain modulation by diffuse noxious inhibitory controls: A systematic review. *Pain*. 2010; 150:309–318. [PubMed: 20557999]
- Price DD, McHaffie JG. Effects of heterotopic conditioning stimuli on first and second pain: a psychophysical evaluation in humans. *Pain*. 1988; 34:245–252. [PubMed: 3186271]
- Pud D, Granovsky Y, Yarnitsky D. The methodology of experimentally induced diffuse noxious inhibitory control (DNIC)-like effect in humans. *Pain*. 2009; 144:16–19. [PubMed: 19359095]
- Raikkonen K, Matthews KA, Flory JD, Owens JF, Gump BB. Effects of optimism, pessimism, and trait anxiety on ambulatory blood pressure and mood during everyday life. *Journal of Personality and Social Psychology*. 1999; 76:104–113. [PubMed: 9972556]
- Scheier MF, Carver CS. Optimism, coping, and health: assessment and implications of generalized outcome expectancies. *Health Psychology*. 1985; 4:219–247. [PubMed: 4029106]
- Scheier MF, Carver CS, Bridges MW. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*. 1994; 67:1063–1078. [PubMed: 7815302]
- Scheier, MF.; Carver, CS.; Bridges, MW. Optimism, pessimism, and psychological well-being. In: Chang, EC., editor. *Optimism and pessimism: Implications for theory, research, and practice*. Washington, DC: American Psychological Association; 2001. p. 189-216.
- Scheier MF, Matthews KA, Owens JF, Schulz R, Bridges MW, Magovern GJ, et al. Optimism and rehospitalization after coronary artery bypass graft surgery. *Archives of Internal Medicine*. 1999; 159:829–835. [PubMed: 10219928]
- Scheier MF, Weintraub JK, Carver CS. Coping with stress: divergent strategies of optimists and pessimists. *Journal of Personality and Social Psychology*. 1986; 51:1257–1264. [PubMed: 3806361]
- Sharot T, Riccardi AM, Raio CM, Phelps EA. Neural mechanisms mediating optimism bias. *Nature*. 2007; 450:102–105. [PubMed: 17960136]
- Solberg Nes L, Segerstrom SC. Dispositional optimism and coping: A meta-analytic review. *Personality and Social Psychology Review*. 2006; 10:235–251. [PubMed: 16859439]
- Sprenger C, Bingel U, Buchel C. Treating pain with pain: Supraspinal mechanisms of endogenous analgesia elicited by heterotopic noxious conditioning stimulation. *Pain*. 2011; 152:428–439. [PubMed: 21196078]
- Staud R, Cannon RC, Mauderli AP, Robinson ME, Price DD, Vierck CJ. Temporal summation of pain from mechanical stimulation of muscle tissue in normal controls and subjects with fibromyalgia syndrome. *Pain*. 2003; 102:87–95. [PubMed: 12620600]
- Streiner DL. Learning how to differ: Agreement and reliability statistics in psychiatry. *Canadian Journal of Psychiatry*. 1995; 40:60–66.
- Sullivan MJ, Bishop SR, Pivik J. The Pain Catastrophizing Scale: Development and Validation. *Psychological Assessment*. 1995; 7:524–532.
- Turk, DC. Biopsychosocial perspective on chronic pain. In: Turk, DC.; Gatchel, RJ., editors. *Psychological approaches to pain management: A practitioner's handbook*. New York, NY: Guilford Press; 1996. p. 3-32.
- Turk DC, Okifuji A. Psychological factors in chronic pain: Evolution and revolution. *Journal of Consulting and Clinical Psychology*. 2001; 70:678–690. [PubMed: 12090376]
- Wager TD, Scott DJ, Zubieta JK. Placebo effects on human μ -opioid activity during pain. *Proceedings of the National Academy of Sciences*. 2007; 104:11056–11061.
- Wilder-Smith CH, Schindler D, Lovblad K, Redmond SM, Nirkko A. Brain functional magnetic resonance imaging of rectal pain and activation of endogenous inhibitory mechanisms in irritable bowel syndrome patient subgroups and healthy controls. *Gut*. 2004; 53:1595–1601. [PubMed: 15479679]
- Willer JC, Le Bars D, De Broucker T. Diffuse noxious inhibitory controls in man: involvement of an opioidergic link. *European Journal of Pharmacology*. 1990; 182:347–355. [PubMed: 2168836]

- Wiech K, Kalisch R, Weiskopf N, Pleger B, Stephan KE, Dolan RJ. Anterolateral prefrontal cortex mediates the analgesic effect of expected and perceived control over pain. *Journal of Neuroscience*. 2006; 26:11501–11509. [PubMed: 17079679]
- Wiech K, Ploner M, Tracey I. Neurocognitive aspects of pain perception. *Trends in Cognitive Neuroscience*. 2008; 12:306–313.
- Villanueva L, Le Bars D. The activation of bulbo-spinal controls by peripheral nociceptive inputs: Diffuse noxious inhibitory controls. *Biological Research*. 1995; 28:113–125. [PubMed: 8728826]
- Yarnitsky D. Conditioned pain modulation (the diffuse noxious inhibitory control- like effect): its relevance for acute and chronic pain states. *Current Opinion in Anaesthesiology*. 2010; 23:611–615.
- Zubieta JK, Bueller JA, Jackson LR, Scott DJ, Xu Y, Koeppe RA, et al. Placebo effects mediated by endogenous opioid activity on μ -opioid receptors. *Journal of Neuroscience*. 2005; 24:7754–7762. [PubMed: 16120776]

Table 1

Pearson correlation coefficients across psychological variables, participants' sex, and the magnitude of endogenous pain inhibition (CPM).

	Variables			
	SEX	LOT-R	PCS	BDI
LOT-R	-0.07			
PCS	-0.07	-0.19 *		
BDI	-0.01	-0.48 **	0.28 **	
CPM	0.18 *	0.13	-0.09	0.02

*
 $p < 0.05$;

**
 $p < 0.01$

Table 2

Assessment of depression, catastrophizing, and dispositional optimism (Mean and standard deviation; SD) as a function of ethnicity.

	Caucasian Americans <i>n</i> = 86 43% female	African Americans <i>n</i> = 28 60% female	Asian Americans <i>n</i> = 35 71% female
Variable	Mean (SD)	Mean (SD)	Mean (SD)
BDI *	5.27 (4.40)	6.00 (5.18)	8.26 (5.35)
PCS	13.23 (8.60)	15.43 (11.46)	15.86 (9.89)
LOT-R	16.28 (5.03)	17.71 (5.08)	15.06 (4.34)

*
 $p < 0.05$

Table 3

Assessment of baseline and concurrent pressure pain thresholds (PPT) during cold water immersion to determine the magnitude of endogenous pain inhibition (CPM) at the forearm and trapezius among African American (AA), Caucasian (CA), or Asian/Pacific Islander (A/PI) cohorts.

Variables	Ethnic Group	Mean (SD)	F
Forearm			
Baseline PPT	CA	339.03 (180.45)	0.40
	AA	326.76 (204.21)	
	A/PI	326.45 (181.70)	
CPT Trials PPT	CA	376.47 (190.23)	1.05
	AA	383.63 (218.73)	
	A/PI	354.44 (191.80)	
CPM	CA	35.35 (96.93)	0.96
	AA	56.86 (89.58)	
	A/PI	28.00 (82.79)	
Trapezius			
Baseline PPT	CA	384.08 (153.42)	0.04
	AA	354.26 (232.38)	
	A/PI	385.57 (186.28)	
CPT Trials PPT	CA	440.58 (184.44)	0.36
	AA	413.32 (256.54)	
	A/PI	454.61 (281.51)	
CPM	CA	55.91 (109.02)	0.65
	AA	59.05 (100.49)	
	A/PI	69.04 (141.62)	
Forearm & Trapezius			
Overall CPM [*]	CA	45.63 (90.86)	0.20
	AA	58.00 (80.41)	
	A/PI	48.54 (94.78)	

Note: All PPT scores are presented as kilopascals (kPa). The magnitude of endogenous pain inhibition (CPM) represents a difference score (CPT trials - baseline PPT) at each site.

* Overall CPM is average of site specific CPM at forearm and trapezius.

Table 4

Multiple regression predicting the magnitude of endogenous pain inhibition (CPM) as a function of optimism.

	R²	B	SEB	β
Variables	.08 [*]			
Sex		36.45	14.89	0.20 [*]
Ethnicity A/PI ^a		8.24	18.39	0.04
Ethnicity AA ^b		17.64	19.86	0.08
PCS		-0.81	0.80	-0.09
BDI		2.27	1.76	0.12
LOT-R		3.38	1.70	0.19 [*]

^a = First dummy-coded ethnicity variable (0 = Caucasian Americans, 1 = Asian/Pacific Islander)

^b = Second dummy-coded ethnicity variable (0 = Caucasian Americans, 1 = African Americans)

^{*} = $p < 0.05$,

^{**} = $p < 0.01$

Table 5

Hierarchical regression predicting the magnitude of endogenous pain inhibition (CPM) with ethnicity as an effect moderator.

	B	SEB	β	R ²	ΔR^2	ΔF
Step 1				0.04	---	2.01
Sex	30.79	14.61	0.17*			
PCS	-0.87	0.80	-0.09			
BDI	0.85	1.55	0.05			
Step 2				0.076	0.036	1.81
LOT-R	3.38	1.70	0.19*			
Ethnicity A/Pl ^a	8.24	18.39	0.04			
Ethnicity AA ^b	17.64	19.86	0.08			
Step 3				0.082	0.006	0.45
LOT-R X Dummy 1 A/Pl ^a	-1.07	4.02	-0.03			
LOT-R X Dummy 2 AA ^b	3.15	3.86	0.08			

^a = First dummy-coded ethnicity variable (0 = Caucasian Americans, 1 = Asian/Pacific Islander)

^b = Second dummy-coded ethnicity variable (0 = Caucasian Americans, 1 = African Americans)

* = $p < 0.05$,

** = $p < 0.01$