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Pain catastrophizing mediates the relationship between trait happiness and depressive symptoms in individuals with current pain

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Abstract

Objective—There is an extensive relationship between chronic pain and depression; however, there is less research examining whether pain-specific factors, such as pain intensity, predict depression, above and beyond the role of normative factors, such as positive emotions. The current study characterized the independent contributions of pain intensity, pain catastrophizing, and a trait measure of happiness to self-rated depressive symptoms.

Methods—We recruited and enrolled 70 volunteers across 3 groups of participants: two groups of patients with current low back pain (one group on opioids and one group opioid-naïve), and individuals in a methadone maintenance treatment program.

Results—Of note, participants reporting concurrent opioid use reported significantly higher levels of depressive symptomatology, although study groups did not differ on any other clinical variables. In our path model, we failed to find direct relationships between pain (intensity or duration) and either trait happiness or depressive symptoms ($p > .05$). However, our analysis did reveal that individuals with chronic back pain who reported higher levels of trait happiness reported lower levels of depressive symptomatology; this effect was significantly mediated by lower levels of pain catastrophizing (standardized $ab = -.144$, $p = .002$).

Conclusion—Our analysis suggests that trait happiness, while unrelated to ongoing pain, may predict a decreased vulnerability to depressive symptoms in individuals with chronic pain, which may operate via lower levels of pain catastrophizing.

Keywords

Pain; pain catastrophizing; subjective happiness; depressive symptoms

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Introduction

Pain becomes harmful when it progresses from an acute to a chronic condition, as chronic pain contributes to prolonged difficulty with continued function and psychological well-being. Chronic pain also contributes to sustained dysregulation of emotional states; greater levels of pain intensity are predictive of lower levels of day-to-day positive affect and greater day-to-day levels of negative affect and depressive symptoms (Sturgeon & Zautra, 2013b). Chronic pain has also been associated with negative outcomes like depression (Brown, Nicassio, & Wallston, 1989; Harris, 1999; Herr & Mobily, 1992) and obesity (Marks, 2007). The ability to understand emotional and cognitive factors that contribute to chronic pain is important due to the prevalence of this symptom. Community-based study estimates of the prevalence of some type of recurrent pain in the previous year range between 14% and 53% (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006; Crook, Rideout, & Browne, 1984; Elliott, Smith, Hannaford, Smith, & Chambers, 2002; Magni, Caldieron, Rigatti-Luchini, & Merskey, 1990).

Coping responses to pain may be automatic or effortful; some studies have shown evidence that chronic pain adversely affects health and well-being through maladaptive cognitive and affective processes like catastrophizing (Sullivan, Bishop, & Pivik, 1995) or when individuals engage in passive or avoidant coping strategies (Zautra, Hamilton, & Burke, 1999). Pain catastrophizing, for example, is a maladaptive pain response defined as a cognitive and affective overreaction to painful episodes (Keefe, Brown, Wallston, & Caldwell, 1989; Sullivan et al., 2001). This strategy has been shown to explain the relationship between pain and psychological disorders like depression (Marks, 2007; Sullivan et al., 1995). Additionally, catastrophizing predicts higher levels of negative affect (Janssen, 2002) and decreased positive affect in people with chronic pain (Jones, Rollman, White, Hill, & Brooke, 2003). Furthermore, pain catastrophizing has been found to mediate the relationship between daily pain intensity and daily levels of negative affect, positive affect, and depressive symptoms (Sturgeon & Zautra, 2013a). Pain catastrophizing thus appears to be a significant risk factor for emotional distress in individuals coping with a chronic pain condition. Conversely, positive emotions may play a key role in determining emotional health in individuals with chronic pain. Positive affective states have previously been identified as a key contributor to effective pain adaptation (Finan & Garland, 2015; Smith & Zautra, 2008), and may aid in recovery from depression (Fredrickson & Joiner, 2002).

In many measures of positive affect, respondents are asked to rate their levels of positive and negative affect over a particular period of time. Researchers have posited that happiness, in addition to being a fluctuating state, may contain a more stable component. This hypothesis has been measured in studies examining “subjective happiness,” a trait-like measure of happiness that be measured with the Subjective Happiness Scale (Lyubomirsky & Lepper, 1999). Although greater pain intensity is predictive of lower levels of day-to-day positive affect in some studies (J. A. Sturgeon & Zautra, 2013b), pain may not show the same magnitude of a negative relationship with trait levels of happiness. However, to date, there have been few studies that examine trait “subjective happiness” and how it might correspond to concurrent pain coping and mood states. One study, for example, did find that subjective

happiness did not correlate with the severity of pain, but did correlate with general health perception (Takeyachi et al., 2003).

Given the lack of research in this area, we sought to further examine the relationship between emotional states, pain intensity, and catastrophizing in the current study.

Prior evidence suggests that higher levels of both pain intensity and pain catastrophizing are associated with decreased *state* levels of positive affect in people with chronic pain. We therefore expected to replicate these relationships of pain and catastrophizing with a *trait* measure of subjective happiness. Similarly, we hypothesized a positive relationship between pain intensity and symptoms of depression. Consistent with prior evidence that happiness may attenuate the negative effects of pain and catastrophizing (Finan, Quartana, & Smith, 2013; Hood, Pulvers, Carrillo, Merchant, & Thomas, 2012), we tested pain catastrophizing as a mediator of the relationship between subjective happiness and depression, with the expectation that individuals who reported greater levels of trait happiness would be less susceptible to maladaptive pain coping responses and emotional distress.

To test these relationships, the current study sample was composed of individuals with chronic back pain, with a subsample of individuals currently taking opioid pain medications and a subsample not taking opioids. Additionally, a sample of individuals, some with chronic back pain, in a methadone maintenance treatment program (MMTP) was included. Studies have shown that chronic severe pain is prevalent among patients in substance abuse treatment, like methadone maintenance treatment programs (MMTPs)(Rosenblum et al., 2003). Other studies have shown that opioid users have a lower health-related quality of life, higher occurrence of depression and more frequent use of coping strategies like catastrophizing (Jensen, Thomsen, & Højsted, 2006). Additionally, in the general population, depressive, anxiety, and drug abuse disorders are associated with an increased use of opioids (Sullivan, Edlund, Zhang, Unützer, & Wells, 2006).

Materials and Methods

Participants

Participants were recruited from the community surrounding Stanford University. We recruited a community sample through various advertising media and outreach to local pain management and substance abuse programs. We enrolled adults for three characterization groups: individuals with chronic low back pain not on opioids (cLBP−), individuals with chronic low back pain on opioids (cLBP+), and individuals with chronic back pain in a methadone maintenance program (MM). For the cLBP− and cLBP+ groups, we defined chronic low back pain as axial low back pain (primary pain condition, without sciatic/radicular symptoms) lasting greater than three months with average pain rated as ≥ 4 on 0–10 scale over the last month. Individuals in the cLBP− group did not use opioids within the last 90 days nor use opioids for at any time for more than 30 days. Individuals in the cLBP+ group used at least 45mg morphine equivalents daily, with opioid use greater than 90 days. Individuals in the MM group had to be maintained in a daily methadone treatment program for at least 90 days. Participants in the MM group were not required to have chronic pain,

though 14 out of the 32 participants in this group did report some level of recurrent pain over the previous 30 days.

All participants provided informed consent and were monetarily compensated for their time. All study protocols were approved by the Stanford University Institutional Review Board.

Questionnaires

We collected data and questionnaires on several domains: demographics, sensory, affective, and experience of life. Below are brief descriptions of measures used in the current study.

Trait happiness

We used the Subjective Happiness Scale (SHS), developed to measure trait happiness. This measure is characterized by high internal consistency, a unitary factor structure, and stability over time. This measure has demonstrated adequate construct validity, correlating highly with other happiness measures (Lyubomirsky & Lepper, 1999). Participants were asked to rate on a scale from (1) 'not at all' to (Wolfe, Ross, Anderson, Russell, & Hebert) 'a great deal', how each statement characterized them. We opted to exclude one item from this scale ("Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be") due to the ambiguity of the wording, resulting in a three-item questionnaire. The three-item version of the SHS has been shown to perform comparably to the four-item version (O'Connor, Crawford, & Holder, 2015). The internal consistency of the 3-item measure was high (Cronbach's α = .885). The included items from the SHS can be found in Appendix 1.

Depressive symptoms

We used the Beck Depression Inventory (BDI-II) to quantify levels of depressive symptoms over the previous 2 weeks. The BDI-II test contains 21 self-report statements measured on a four-point scale from 0 (no symptoms) to 3 (very intense symptoms). The BDI-II test has demonstrated adequate psychometric properties in prior studies, including high reliability and content and discriminant validity (Wang & Gorenstein, 2013). The internal consistency of the BDI-II in the current sample was high (Cronbach's α = .937).

Pain intensity

For participants with current back pain, data were collected regarding pain intensity over the past 4 weeks (0 – 10 numeric rating scale with anchors of "No Pain" and "Worst Possible Pain"). For acute and chronic pain populations, numeric rating scales have been identified as suitable assessments of pain intensity (Cook et al., 2013).

Pain catastrophizing

Pain catastrophizing was assessed using the 13-item Pain Catastrophizing Scale (PCS) (Sullivan et al., 1995). This scale assesses pain catastrophizing according to a 3-factor model: an inability to disengage from negative thoughts about pain, feelings of helplessness in managing pain and its negative consequences, and magnification of the negative consequences of pain. The internal consistency of the PCS was high (Cronbach's α = .935).

Statistical Analysis

Path modeling analyses were conducted using Mplus version 6.12, (Muthén & Muthén, 2007), while demographic analyses, correlations, and internal consistencies were conducted using SPSS Version 21. Differences between the cLBP+, cLBP−, and MM groups on all study variables were examined using one-way analysis of variance (ANOVA) models, with Bonferroni-corrected post-hoc comparisons if the omnibus F-score was found to be significant. Chi-square tests were conducted to examine group differences in demographic variables (income, ethnicity, sex), which were coded as categorical variables. Path models were constructed estimating the direct effects of pain intensity and happiness on pain catastrophizing, as well as the direct effects of pain intensity, happiness, and pain catastrophizing on depression. Mediation analyses were conducted using a 1000-draw bootstrap-estimated *ab* product of coefficients method (MacKinnon, Lockwood, & Williams, 2004), which estimates the product of the path coefficients representing the effect of the predictor on a mediating variable (the *a* path) and the effect of a mediating variable on an outcome (the *b* path). Significance of the mediated effect was set at an alpha level of .05. All path coefficients in the current model are standardized, to represent the relative size of each effect in the model. A categorical variable representing opioid status (i.e., inclusion in the cLBP+, cLBP−, or MM group) was also included as a covariate in all paths.

Results

Participants (Demographics)

We enrolled a total of 70 participants in the study. Demographic data (including sample size) are shown in Table 1. Our sample was recruited from the local community, and participants identified their race/ethnicity as Caucasian (n = 44), Asian (n = 4), Mexican/Latino/Hispanic (n = 12), African American (n = 7), or Other (n = 3). Chi-square tests suggested that the 3 groups did not significantly vary according to sex or racial/ethnic makeup, but did indicate that the MM group had significantly more participants with lower income compared to the cLBP− group ($\chi^2(1) = 11.8$, $p = .001$; no other significant differences in income were noted between groups.

Group Differences of Happiness and Depression

Our sample distribution was skewed towards no depression on the BDI, with 49 participants categorized as “minimal” (0–13 score), 9 as “mild” (14–19 score), 4 as “moderate” (20–28), 7 as “severe” (29–63), and 1 with missing data. Variance of the Subjective Happiness Scale did not vary between the cLBP+, cLBP−, and MM groups. We failed to find significant differences in the Subjective Happiness Scale between the three groups, $F(2, 67) = 1.64$, $p > .05$. Variance between in the BDI between the three medication groups was not equal (*Levene Statistic* = 3.16, $p = .049$), likely due to the smaller sample size in the cLBP+ and MM groups. Consequently, the group differences in BDI scores were measured using a Welch ANOVA, which is robust against violations of the homogeneity of variance assumption. Results of the Welch ANOVA revealed significant differences on the BDI-II, ($F(2, 21.94) = 6.53$, $p = .006$); Bonferroni-adjusted post-hoc comparisons suggested significantly lower BDI scores in the cLBP− group compared to the cLBP+ and MM groups ($p < .03$ in both cases). No other group differences were noted in terms of BDI scores. Group

comparisons of subjective happiness scores and BDI-II scores are shown in Figure 1. Average pain intensity and pain catastrophizing scores also did not significantly vary between groups.

Effects of pain intensity, pain catastrophizing, subjective happiness on depressive symptoms

Data from 70 participants in the cLBP+ (N = 13), cLBP− (N = 43), and MM (N = 14) groups were included in the path analysis. To test the hypothesis that there would be a positive relationship between pain intensity and symptoms of depression, we ran Pearson correlations between different study variables for group of participants, as shown in Table 2. Additionally, to test the hypothesis that individuals with greater levels of trait happiness would be less susceptible to maladaptive pain coping responses, we tested a path model. Figure 2 depicts this model, in which pain intensity, subjective happiness, and pain catastrophizing were modeled as predictors of concurrent depression. The total effect of subjective happiness on depressive symptoms was significant (standardized $\beta = -.670$, $p < .01$), while the total effect of pain intensity on depressive symptoms was not statistically significant (standardized $\beta = .143$, $p > .10$). In the fully-specified model, greater pain intensity scores significantly predicted higher levels of pain catastrophizing but were unrelated to concurrent depressive symptoms (standardized $\beta = -.027$, $p = .74$). Similarly, both pain catastrophizing and subjective happiness were found to significantly predict depressive symptoms. Notably, there was not a significant correlation between pain intensity and subjective happiness (Pearson $r = .023$, $p = .85$). Pain catastrophizing was found to be a significant mediator of the relationship between subjective happiness and depressive symptoms (standardized $ab = -.144$, $p = .002$). Given that there was not a significant bivariate relationship between pain intensity and depressive symptoms, we opted not to test whether pain catastrophizing was a mediator of this relationship. Proportion of variance (r^2) estimates suggested that 57.8% of variance in depressive symptoms scores, and 22.8% of the variance in pain catastrophizing scores were accounted for by predictors in this model. As income was found to significantly vary between groups, we subsequently included it as a covariate in the final estimated model. However, its inclusion did not change the direction or significance of any of the estimated paths, nor did income significantly predict depressive symptoms or pain catastrophizing, above and beyond the effects of other predictors ($p > .30$ in both cases).

Discussion

We explored the relationship between chronic pain, subjective happiness, and depressive symptoms in individuals with chronic pain, with and without concurrent use of opioids. We also examined whether the presence of chronic pain and current opioid status predicted differences in mean levels of pain intensity, depression, happiness, and pain catastrophizing. Of note, we found no mean differences across study groups in any of the examined clinical variables, with one exception: participants who were currently using opioids (either those in the MM or cLBP+ group) reported significantly higher scores on depression than individuals with ongoing chronic low back pain who were not using opioids.

Further, our path modeling analysis suggested significant negative relationships of subjective happiness ratings with depressive symptoms and pain catastrophizing scores. Notably, pain catastrophizing was found to be a significant mediator of the relationship between happiness and depressive symptoms.

Our results, consistent with previous findings, suggest that pain catastrophizing is associated with higher levels of negative emotion (Janssen, 2002; Sturgeon & Zautra, 2013b). However, the fact that depressive symptoms were unrelated to the average severity of pain reported by participants was in contrast to many prior studies that have suggested a positive relationship between pain intensity and depressive symptoms (Arnstein, Caudill, Mandle, Norris, & Beasley, 1999; Brown, 1990; Haythornthwaite, Sieber, & Kerns, 1991). This lack of a relationship between pain intensity and depressive symptom severity, while surprising, has been noted in some prior studies (Von Korff et al., 2005). In fact, studies in which there is no relationship between pain intensity and depressive symptoms it have suggested that it is related to a pain-related sequelae, such as pain catastrophizing (Keefe et al., 1989) or pain-related disruption in normal functioning (Von Korff et al., 2005), that more meaningfully predicts pain-related mood disruption. We found that pain catastrophizing was not only significantly and positively related to pain intensity but also predicted the severity of depressive symptoms to a greater degree than pain intensity alone. These results suggest that it is how people think about their own pain, rather than the intensity of the pain itself, that predicts the severity of depressive symptoms. Further, we have expanded this model by demonstrating that the cognitive appraisal of pain states may be dependent on traits such as subjective happiness.

In the current study, participants who reported greater trait levels of happiness tended to report lower levels of pain catastrophizing and depression. This pattern of results provides further support that the presence of positive emotions is a protective factor against negative cognitive and emotional states that may be exacerbated by chronic pain. Notably, however, trait levels of happiness were unrelated to the typical severity of pain reported by participants. This pattern of findings stands in contrast to prior studies that have suggested a negative relationship between pain intensity and positive emotional states (Rainville, Bao, & Chrétien, 2005; Strand et al., 2006). One possible explanation for this non-significant relationship may concern the use of differing time frame in our measures. The aforementioned studies by Strand and Rainville examined relationships of pain with more state-like versions of positive emotion, such as positive affect in the past week or positive affect ratings during an experimental session. Our study looked at trait levels of happiness, a construct that has been shown to be uncorrelated with pain intensity in one prior study (Takeyachi et al., 2003) and likely would not be expected to vary significantly according to more state-like factors such as pain intensity. Consequently, our use of a more stable happiness measure demonstrates that participants who viewed themselves as generally happier people appear to be less susceptible to the deleterious emotional consequences of pain.

Further, we noted that those participants on opioids were more likely to have higher depressive symptoms than those patients not on opioids, suggesting that concurrent use of these medications might also play a key role in the relationship between pain and

depression. This pattern of findings has been noted previously, as concurrent use of opioids has been shown to be a predictor of lower life satisfaction (Luty & Arokiadass, 2008), as well as lower health-related quality of life, higher occurrence of depression and more frequent use of coping strategies like catastrophizing (Jensen et al., 2006). As concurrent medication use has not always been reliably reported in research studies involving individuals with chronic pain, it may be that opioid use constitutes another potential risk factor for pain-related mood disruption. Our use of data from individuals with chronic low back pain, including those on long-term opioid regimens such as methadone maintenance, may demonstrate an elevated vulnerability to psychiatric distress among these patients, above and beyond the more typical risk factors associated with poor pain-related outcomes, such as pain catastrophizing. Notably, however, the other effects in our path model occurred independently of opioid status, and it would have been ideal to test whether or not these effects were dependent on a participant's opioid status (i.e., as a moderator). Although we were unable to conduct this analysis due to the relatively small size of the opioid groups, our results may constitute preliminary evidence for the potential exacerbating role of opioid use for psychological distress. Consequently, identification of the synergistic effects of pain, catastrophizing, and opioid use in future studies may yield incrementally more valuable information regarding risks for depression for individuals with chronic pain.

Limitations

Some limitations of our current findings should be acknowledged. First, our study estimated a path model using cross-sectional data; consequently, we cannot definitively state that the ordering of variables depicted in this model represents the true causal ordering of effects. It is also notable that our data were collected from several different surveys and thus included measures from different time frames. For example, the BDI asked about symptoms over the past two weeks, the pain survey asked about symptoms over the past four weeks, and the subjective happiness scale prompted participants to rate their levels of happiness in general. These differences in measurement may explain, for example, the lack of a significant relationship between pain intensity and depression, which has been noted in a myriad of prior studies.

Further, there are some limitations in the current study sample that should be noted. Although the diversity of our chronic pain sample improves the generalizability of our study findings, we were unable to recruit an adequately-sized sample of individuals with chronic back pain who reported ongoing opioid use or ongoing methadone maintenance. Our difficulty in recruiting individuals with ongoing opioid use was unexpected, given the relative ubiquity of opioid prescribing for the management of chronic pain (Levy, Paulozzi, Mack, & Jones, 2015). As a result, our conclusions about the risk factors associated with opioid use must be tempered somewhat, as our sample size did not permit us to examine group membership as a moderator of the effects noted in our presented path model. Similarly, our relatively small sample size increases the likelihood of Type II error, which may be a salient concern in the current study. As noted previously, the lack of an association between pain intensity and depressive symptoms was surprising, and there is a possibility that this non-significant relationship (or, similarly, the lack of an association between pain intensity and subjective happiness ratings) may be attributable to the sample size of the

current study and not to a genuine lack of association between these variables. Consequently, the results of the current study should be interpreted only as preliminary data that require validation in larger samples to ensure that they are reliable.

Directions for Future Research

Future studies should address the inclusion of social and physical function within this model, which may be significant moderators of the relationship between subjective happiness and depressive symptoms (John A Sturgeon, Dixon, Darnall, & Mackey, 2015). Additionally, because each of our study groups was not of sufficient size to test for the effect of opioids as a moderator with sufficient statistical power, a future study utilizing a larger sample of individuals with chronic pain, both those using and not using opioid medications, may demonstrate how opioid use plays a role in this model of happiness, catastrophizing, and depression. Lastly, because we looked at our variables at only one point in time (pain catastrophizing scores, pain scores, subjective happiness scores, and BDI scores), we cannot rule out alternative models of causality that may change the ordering of study variables. Future studies that examine these variables longitudinally can examine whether these measures change over time and examine whether or not the proposed mediating model is supported when temporal precedence can be more clearly established.

A higher trait level of happiness was found to be a predictor of lower pain catastrophizing and lower levels of depressive symptoms, an important factor in chronic pain. Thus, targeting happiness may be useful intervention for those with chronic pain. Studies have shown that a positive psychology intervention may have beneficial effects for some chronic pain patients to improve well-being and pain-related outcomes (Flink, Smeets, Bergbom, & Peters, 2015; Muller et al., 2015). In addition to more traditional psychological approaches, such as teaching strategies for reducing pain catastrophizing, Clinicians may effectively address emotional distress in patients with chronic pain by supporting attempts to increase subjective happiness. Our results highlight the potential importance of these interventions, and suggest that pain-relevant mood states may be modified by concurrent medication use. We urge further attention to this question in future studies.

Conclusions

The current study utilized a moderate sample of individuals with diverse chronic pain conditions to examine the independent effects of pain and pain catastrophizing on concurrent levels of subjective happiness and depression. Our results highlight the relative importance of happiness and how people think about their pain when discussing depression.

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Appendix 1. Subjective Happiness Scale (15)

For each of the following statements and/or questions, please circle the point on the scale that you feel is most appropriate in describing you.

1. In general, I consider myself:								
not a very happy person	1	2	3	4	5	6	7	a very happy person
2. Compared with most of my peers, I consider myself:								
less happy	1	2	3	4	5	6	7	more happy
3. Some people are generally very happy. They enjoy life regardless of what is going on, getting the most out of everything. To what extent does this characterization describe you?								
not at all	1	2	3	4	5	6	7	a great deal

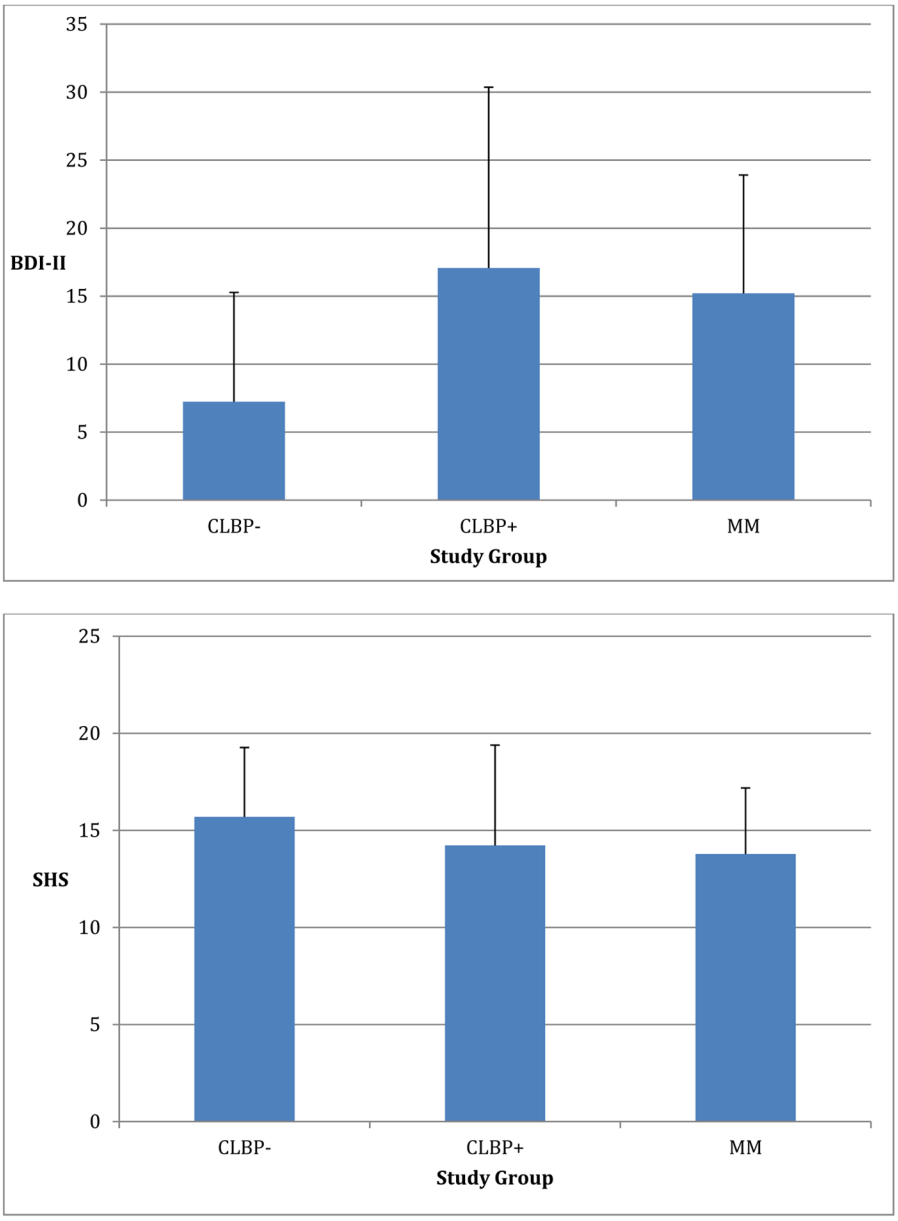

Figure 1.
Subjective Happiness Scale (3 items) and BDI-II scores by study group.

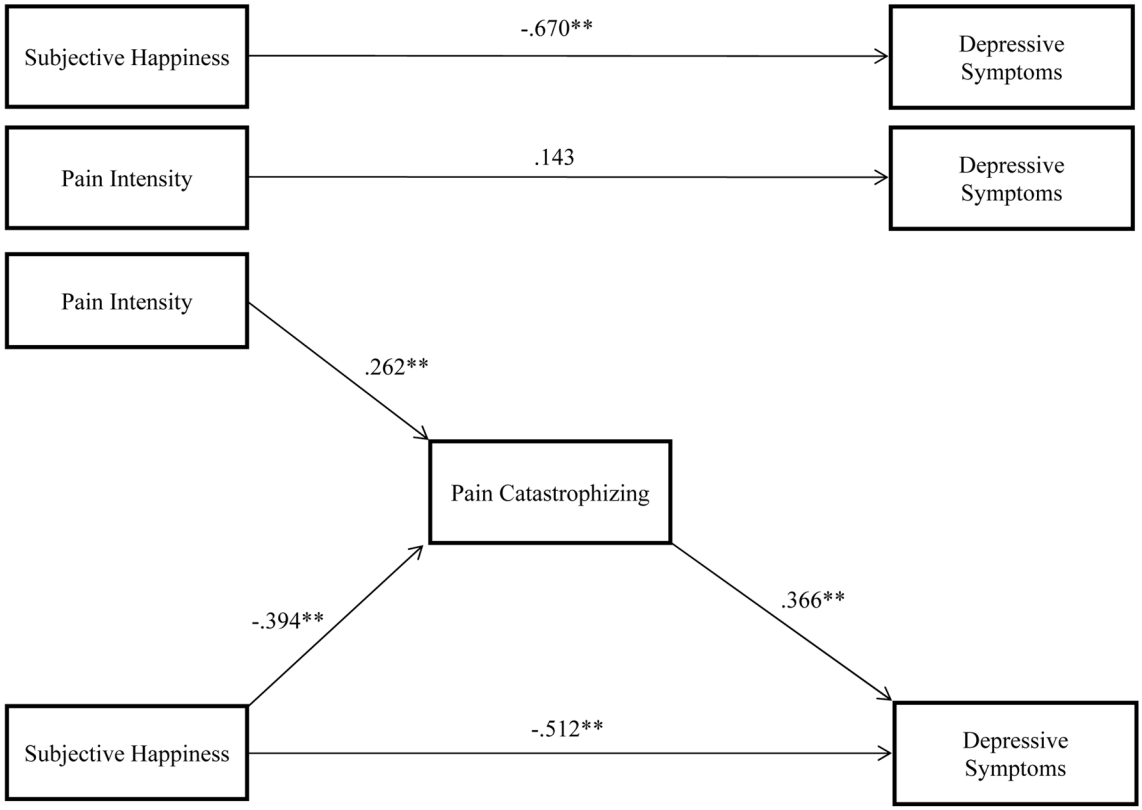

Figure 2.
Path model representing effects of pain intensity, pain catastrophizing, and subjective happiness on depressive symptoms.

Table 1

Demographics

Means and Standard Deviations of Study Variables.

Group	Sample Size	Mean Age (SD, Range)	Gender (M, F)	Mean Income * (SD)	Pain Intensity** (SD, Range)	PCS (SD, Range)
Low Back Pain (no opioids)	43	40.4 (11.2. 21–65)	21, 22	5.1 (2.2)	4.7 (1.9, 1.0 – 9.0)	17.1(9.7, 2–45)
Low Back Pain (opioids)	13	51.3 (20–64)	9, 4	4.7 (3.1)	5.3 (2.4, 1.5–9.0)	23.5(13.4,2–44)
Methadone Maintenance	14	48.8 (11.4, 26–63)	10, 4	3.4 (3.1)	6.1 (2.2, (2.0–10.0)	22.9(10.6, 10–41)

* Income Bands of 1 to 9 (1 is less than $10,000; 2 is $10,000 – $19,999; continues in increments up to 9, which his $80,000 or more)

** Verbal pain ratings on a scale of 0 – 10 (0 is no pain, 10 is worst pain; average taken from two ratings during first experimental session)

Note: PCS = Pain Catastrophizing Scale

Table 2

Correlations Between Study Variables

	Subjective Happiness	Pain Catastrophizing	Depressive Symptoms	Pain Intensity
Subjective Happiness	1	−.402**	−.619**	.005
Pain Catastrophizing		1	.628**	.306**
Depressive Symptoms			1	.143
Pain Intensity				1

Scores are based on data from 70 individuals with chronic pain.

Note:

** $p < .01$,

* $p < .05$