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The Effect of Emotional suppression on Attentional Bias toward Pain-related information in Individuals with Chronic Pain†

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This study investigated the effects of the emotion regulation strategy of emotion suppression on attentional bias toward painful stimuli in individuals with chronic pain. The participants were divided into a chronic pain group (N = 55) and a healthy control group (N = 55), and they were asked to practice one of two emotion regulation strategies (cognitive reappraisal and emotional suppression). The results showed that the chronic pain group that using emotional suppression showed more extended duration of painful expressions than the control group. Using cognitive reappraisal, the chronic pain group exhibited relatively short durations of painful expressions. This suggests that emotional suppression increases attention to pain‐related information in individuals with chronic pain. To use of adaptive emotion regulation strategies is essential to reduce attention biases leading to a better adaptive daily life.

Keywords: Chronic pain, Emotion Regulation Strategy, Attentional Bias, Negative affectivity, emotional suppression

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INTRODUCTION

Individuals with chronic pain have an attentional bias toward pain-related information, which contributes to developing and maintaining the intensity of pain and pain-related problems (Haggman, Sharpe, Nicholas, & Refshauge, 2010; Khatibi,Dehaghani,Sharpe,Asmundson,&Pouretemad,2009; Kim,Jung, Wang, & Cho, 2020). Increased attentional bias toward pain-related information is related to pain-related fears and anxiety, which may lead to the individual avoiding activities and situations that could increase pain intensity(Vlaeyen & Linton, 2000). This vicious cycle contributes to emotional problems, such as depression and anger(Solberg Nes, Roach, & Segerstrom, 2009). Given this, attentional bias to pain-related information could have an impact on pain intensity and pain-related problems.

A number of theoretical models such as the Schema Enmeshment Model of Pain(SEMP; Pincus & Morley, 2001), a motivational account of attention to pain (Van Damme, Legrain, Vogt, & Crombez, 2010), and the Fear-Avoidance (FA) model (Vlaeyen & Linton, 2000) indicate that individuals with chronic pain exhibit attentional bias toward pain-related information. Although numerous studies identify attentional bias toward pain-related information in individuals with chronic pain, the results of these studies have been inconsistent. Individuals who have chronic pain pay attention to pain-related cues when the stimuli are presented (Dehghani, Sharpe, & Licholas, 2003; Khatibi et al., 2009; Liossi, Schoth, Godwin, & Liversedge, 2014; Schoth & Liossi, 2010). A recent study revealed that those with chronic pain tend to pay attention to pain-related words, and those with high pain catastrophizing tend to view pain-related words longer than neutral words (Lee, Beom, Choi, Wachholtz, & Lee, 2019). It was also found that there was no difference in attentional bias for painful expression between the chronic pain group and pain-free group (Asmundson, Carleton, & Ekong, 2005; Asmundson, Wright, & Hadjistavropoulos, 2005; Lee et al., 2019; Lee, Ahn, Wachholtz, & Lee, 2020; Priebe et al., 2021).

Individuals with chronic pain may exhibit higher negative affectivity than healthy people (Wong et al., 2015; Zautra, Smith, Affleck, & Tennen, 2001), and this negative affectivity may be the result of difficulties in emotion regulation (Solberg Nes et al., 2009). According to Gross's generative process model, emotion regulation includes two strategies, each of which produces different experiential, physiological, and cognitive-behavioral responses: An antecedent-focused strategy, such as cognitive reappraisal, intervenes before the trend of emotional response fully develops and effectively changes subsequent emotions; and response-focused

strategies, such as emotional suppression, are relatively slow in the process of generating emotions and reduce behavioral expressions by modifying the behavioral aspects of emotional responses (Gross, 2002; Gross & John, 2003). Among other strategies, chronic pain is directly and indirectly related to suppression and reappraisal strategies, respectively.

Although chronic pain studies have not investigated the effects of emotion regulation on attentional bias toward pain-related information, previous research has found that participants who adopt a reappraisal strategy attended to negative stimuli less and distracted their attention from a negative expression to a lower degree of arousal (De Raedt & Koster, 2010; Strauss, Ossenfort, & Whearty, 2016). Conversely, participants who adopted emotional suppression attended to negative stimuli to a greater degree and had more difficulty in engaging from negative stimuli to lower arousal stimuli (Szasz, Szentagotai, & Hofmann, 2012).

In previous studies that identified attentional bias toward pain-related cues, behavioral measurements such as the dot-probe task were used. In such tasks, a stimulus is presented discontinuously, thus direct attentional patterns cannot be measured directly, adopting selective attention (Asmundson et al., 2005; Baum et al., 2013). Selective attention consists of two mechanisms: the initial gaze direction and the gaze duration (Allport, 1989). To identify the two mechanisms, direct measurement of the eye movement is a suitable. Eye movement is a physiological response that can help individuals directly and objectively measure intentional attention deflection and automatic attention (Kowler, 1995). Although it may be difficult to instruct individuals with respect to emotion regulation strategies in the laboratory, previous studies have identified differences between groups that used different emotion regulation strategies while watching negative emotion-inducing videos (Jang, Park, & Lee, 2012; Kno & Kwon, 2021). In one such study, the cognitive reappraisal group exhibited a larger reduction in positive emotions than the emotional expression group (Jang et al., 2012).

This study examined the effects of emotion regulation strategies, such as cognitive reappraisal and emotional suppression, on attentional bias toward painful expressions in individuals with chronic pain. The main result is as follows: The chronic pain group that practiced emotional suppression exhibited pain expressions for a longer period than the control group.

METHOD

Participants

A total of 248 people were recruited from on-line and off-line advertisements from C

university located in Seoul, Korea and 110 participants who met the criteria participated in the experiment. Participants experiencing chronic pain or non-pain were recruited. Inclusion criteria were the presence of chronic pain diagnosis, pain duration more than 3months (Treed et al., 2015). All participants were randomly assigned and divided into cognitive reappraisal group, N = 55, and emotional suppression group, N = 55. This study was approved by the university Institutional Review Board (NO. 1041078-201910-HRSB-311-01).

Questionnaires

Pain Intensity Questions. Pain Intensity Questions include 2 items assessing the degree of the pain during the past three months and the pain during the past week. It was rated on a 11-point scale that range from 0 (*no pain*) to 10 (*very severe pain*).

Positive and Negative Affect Scales: State Version (PANAS). The PANAS is 20 items consisting of adjectives describing negative or positive emotions. Participants rated each adjective on a 0 to 4 scale (0 is *not at all* to 4 is *extremely*) according to positive or negative affect. PANAS has good reliability and validity (Watson, Clark, & Tellegen, 1988). Internal consistency (Cronbach's α) of this study was .80 (PAS) and .76 (NAS).

Strategy Compliance. To assess compliance with the instructions while watching the video clip, participants had to rate two statements on a 100 mm VAS word-anchored at each end (*very untrue to very true*; Svaldi, Tuschen-Caffier, Trentowska, Caffier, & Naumann, 2014). The items were as following: Emotional suppression group- 'While watching the clip, I concealed my feelings from outside' , 'While watching the clip, I succeeded to conceal my feelings from others'. Reappraisal group- 'While watching the clip, I developed sort of an objective distance', 'While watching the clip, I succeeded to develop sort of an objective distance'. Internal consistency (Cronbach's α) of this study was .92 (emotional suppression) and .85 (reappraisal).

Mood Induction (Video clip)

Negative emotions (sadness, anger, fear) were induced through 6 minutes clip which intended to increase negative emotions. Two video clips were presented to each participant. These video clips were the same as arousal and valence for reducing the practice effect. The order in which the video clips were presented was counterbalanced. Video clips inducing negative emotions were taken from different movie clips and included high arousal and negative valence. These movie clips have been found to be suitable for inducing negative emotions in

previous studies (Lee & Choi, 2009). In this study, there may be ethical issue with the induction of negative emotions, so video clip was also shown to induce positive emotion.

Emotion Regulation Strategy

Participants were manipulated to use an emotion regulation strategy (cognitive reappraisal and emotional suppression) by the researcher. Examples of instructions are as following. Cognitive reappraisal group (Richards & Gross, 2000; Hofmann, Heering, Sawyer, & Asnaani, 2009): Watching this video will not cause a bad situation and you don't have to be nervous at all. Emotional suppression group (Richards & Gross, 2000): You don't have to smile, tears, laugh out loud, get angry, shout, or be surprised when watching a horror movie.

Free Viewing Task

To measure eye movement for pain-related stimuli, a free viewing task was conducted using the painful/angry/neutral expressions. To assess attentional bias on painful expressions, a total 8 pairs of painful expressions and neutral expressions were used. 8 pairs of angry expressions and neutral expressions were also used because of distinguishing whether attention is biased in painful stimulus itself or high arousal stimulus. The pairs of expressions were presented randomly by changing the position of the left and right two times.

As an experimental stimulus, photos displaying facial expressions were obtained by the Extended ChaeLee Korean Facial Expression of Emotions (KUFEC) that included different facial expressions such as anger, disgust and neutral (ChaeLee-E; Lee, Kim, Yeon, Kim, & Chae, 2013). Since there were no painful expressions in KUFEC, painful expressions were created from anger and disgust expressions. A pilot study was conducted to validate photos displaying pain expression and 8 participants rated the pain level, arousal of each pain expression on 7-point scale, pain level was M=5.5. SD=0.28, arousal was M=4.75, SD=0.15.

The picture stimuli were presented in the following order (Sanchez, Vazquez, Marker, LeMoult, & Joormann, 2013): black screen (500ms), initial central fixation (500ms), a random number (1,000ms), and naturalistic viewing of face pairs (3,000ms).

Procedure

All participants arrived at the laboratory and signed the consent form. Participants were randomly assigned the emotion regulation condition (i.e., cognitive reappraisal or emotional suppression). Participants were instructed to complete the following self-reported questionnaires and tasks: Before mood induction,

participants were instructed to complete the following self-report questionnaires. In pre-strategy, they watched a movie clip and then completed the self-report questionnaires to manipulate check (PANAS) and task (free viewing task). In the strategy stage, participants were instructed to conduct emotion regulation strategy while watching a video clip. Then, they completed the self-report questionnaires for the manipulation check (PANAS, Strategy Compliance) and the task (free viewing task).

Data Analysis

For data analysis, one-way analysis of variance (ANOVA) to analyze differences in characteristics of the groups were performed. To examine the difference between before and after watching the video clips, paired sample t-test and one-way ANOVA were used. Levels of attentional bias were analyzed with 2 (group: chronic pain, control) × 2 (condition: cognitive reappraisal, expression suppression) ANOVAs. The attention bias score was calculated the following way: post (emotion expression score - neutral expression score) - pre (emotion expression score - neutral expression score). Attentional bias was measured using the total fixation duration. To conduct the data analysis, SPSS 23.0 for windows was used for the paired sample t-test, one-way ANOVA, two-way ANOVA.

RESULTS

Group Characteristics

Total of 110 participants were analyzed by the statistical analysis. One-way ANOVAs were conducted to investigate the difference in demographic data and psychological characteristics between the four groups. There were no significant differences in age, $F(3, 106) = .218$, n.s., and PANAS, PAS: $F(3, 106) = 1.931$; NAS: $F(3,106) = 1.602$, n.s. But there was significant difference in pain duration, $\eta 2 = .476$, $F(3, 106) = 32.068$, $p < .01$.

Manipulation Check for Inducing Negative Affect

To examine whether the video clip intended to induce negative affect, the paired sample t-test was conducted. After watching the videos, all participants showed the changes in affect states such as STAI-S, $t(109) = -7.215$, $p < .01$, and PANAS, PAS; $t(109) = 5.930$, $p < .01$; NAS; $t(109) = -5.105$, $p < .01$.

Changing by Emotion Regulation Strategies

Table 1 shows the differences of each score between pre and post emotion regulation

manipulation. To identity the changing scores, Two-way ANOVAs were conducted.

Affect

To examine the difference of emotion regulations between before and after emotion regulation, PANAS scores were analyzed. To examine the change of negative affectivity, PANAS were analyzed by two-way ANOVAs. The results of PAS showed that there was no significant interaction between group and condition, $F(3, 106)=.011$, *n.s.*, and no significant difference in the group and condition, $F(3, 106) = 1.203$; $F(3, 106) = .561$, *n.s.* The results of NAS showed a significant difference in the conditions, $\eta^2 = .066$, $F(3, 106)= 7.523$, $p < .01$. But there was no significant difference in groups and interaction of groups and conditions, $F(3, 106) = 1.297$, *n.s.*; $F(3, 106)=1.244$, *n.s.*

Attention Bias toward Painful Expressions

This study conducted 2 (group: chronic pain, control) × 2 (condition: cognitive reappraisal, emotional suppression) ANOVA to examine the emotion regulation difference in attentional bias. There was a significant interaction on the groups and conditions, $\eta^2 = .073$, $F(3, 106)=8.344$, $p < .01$. There was a significant difference in the conditions, $\eta^2 = .066$, $F(3, 106)=7.535$, $p < .01$, but no significant difference in the groups, $F(3, 106)=0.004$, *n.s.* A result of the Bonferroni post-hoc test represented that the conditions were a significant difference in the chronic pain group, $\eta^2=.073$, $F(1, 108)=15.869$, $p < .01$. But the conditions were no significant difference in the control group, $F(1, 108)=0.010$, *n.s.*

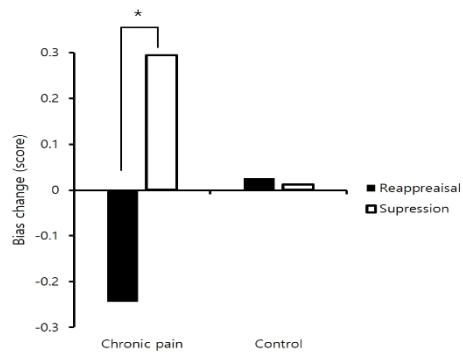

Figure 1. Bias score for painful expressions

*$p < .01$

Table 1. Mean (SD) of changes in score after emotion regulation

	Chronic pain group		Control group		*F*
	Cognitive reappraisal (*N*=28)	Emotional Suppression (*N*=27)	Cognitive reappraisal (*N*=28)	Emotional Suppression (*N*=27)	
PAS	-2.21(3.44)	-1.52(4.77)	-1.14(8.97)	-0.22(3.47)	0.59
NAS	-6.36(5.61)	-1.00(4.77)	-6.89(6.92)	-1.19(6.92)	8.88**
Pain bias	-0.24(0.40)	0.29(0.47)	0.03(0.47)	0.01(0.64)	5.29**
Anger bias	-0.18(0.77)	-0.23(0.76)	0.03(0.38)	0.04(0.64)	1.20

Attention Bias toward Angry Expressions

The result showed that there was a tendency for a significant difference in the group, $F(3, 106)=3.562$, $p=0.062$. In other words, the control group tend to pay more attention to the anger expressions than the chronic pain group. But there was no significant interaction on the groups and conditions, $F(3, 106) = 0.044$, *n.s.*, and no significant difference in conditions, $F(3,106) = 0.020$, *n.s.*

Discussion

This study examined the effects of emotion regulation strategies, such as cognitive reappraisal and emotional suppression, on attentional bias toward painful expressions in individuals with chronic pain. The main result is as follows: The chronic pain group that practiced emotional suppression exhibited pain expressions for a longer period than the control group.

This study concluded that individuals with chronic pain experienced more painful expressions when adopting the emotional suppression strategy than the cognitive reappraisal strategy, but no difference was observed in attentional bias toward painful expression between the strategies in the control group. Although it is known that chronic pain patients tend to pay more attention to pain-related information as a way to avoid pain stimulation, previous studies differed with respect to attentional bias to pain-related information (Haggman et al., 2010; Chan, Suen, Jacksom, Vlaeyen, & Barry, 2020). Considering the previous study results that indicate emotion regulation affects attentional bias, the effect of the emotion regulation strategy on attentional bias in individuals with chronic pain was confirmed in this study. The result is in line with studies that found that emotion regulation could affect attentional bias. Previous studies had found that participants had fewer negative expressions in cognitive reappraisal and more negative expressions in emotional suppression (De Raedt & Koster, 2010; Gross & Thompson, 2007; Koole, 2009; Strauss et al., 2016; Szasz et al., 2012).

The effects of pain-related catastrophizing on attentional bias toward pain-related information based on the fear-avoidance (FA) model have been extensively studied (Haggman et al., 2010; Khatibi et al., 2009). A relevant study demonstrated that negative affectivity affects pain-related catastrophic thinking, which is a major factor in the FA model (Wong et al., 2015), and the emotion regulation strategies that affect this negative affectivity were assigned as a condition to participants to test the attentional bias toward pain-related information in this study. The results showed that the chronic pain group paid longer attention to pain expressions under emotional suppression condition and less

attention under the cognitive reappraisal condition, which may be the result of varying levels of negative affectivity in response to the emotion regulation strategies. These results are different from those found by previous research, which emphasized pain-related catastrophic thinking and fear in attentional bias toward pain-related information.

In this study, angry expressions with high arousal were presented to determine whether the participants experienced pain-related stimuli or arousal stimuli. Unlike the results of attentional bias toward painful expressions, the chronic pain group tended to look less at angry expressions than the control group. This result can be seen as similar to the result of looking less at angry faces than neutral faces in chronic pain group (Lee et al., 2019). This study demonstrates that people with chronic pain pay closer attention to pain-related stimuli as compared to arousal stimuli, especially in stimuli with similar arousal.

The participants were randomly assigned a strategy without taking their emotional suppression strategies into account. People tend to have varied emotion regulation strategies, and the participants were unable to use their own emotion regulation strategies in the experiment. However, the participants' frequent use of varied strategies may have affected the emotion regulation strategy that they used during the experiment. As indicated in the results of the Strategic Compliance Questionnaire, participants employed the indicated strategies accurately.

The present study had several limitations. First, chronic pain is heterogeneous and may be related to various diagnoses. However, our sample grouped all patients with chronic pain together without discriminating chronic pain patients based on their diagnoses. Second, the participants' arousal and valence were measured only through self-report questionnaires after negative emotions were induced. Physiological measurements would be useful to identify arousal and valence when experiencing negative emotions. Finally, only one trial of the emotion regulation strategy was performed. and the emotion regulation strategies used in the experiment may have been only temporarily effective. Future work should examine how long an emotion regulation strategy can be sustained.

Despite these limitations, we found that emotion regulation strategies had different effects between individuals with chronic pain and healthy individuals with respect to attentional bias toward pain-related stimuli. Emotion regulation accounted for attentional biases for pain-related stimuli that negatively affect individuals with chronic pain. When individuals with chronic pain used emotional suppression, negative affectivity and attentional bias toward pain-related information increased, as emotional suppression is directly related to

pain. Therefore, individuals with chronic pain who use emotional suppression can engage in emotion regulation training and eventually adopt a more adaptive strategy.

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만성통증자의 정서 억제가 통증 관련 정보에 대한 주의편향에 미치는 영향

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본 연구에는 만성통증 환자의 정서적 억제 전략이 통증 표정에 대한 주의 편향에미치는영향을확인하였다. 실험은 만성통증군과 비통증군을 대상으로 각각 인지 재평가 집단 또는 표현 억제 집단으로 분류되어 진행되었다. 실험은 두 단계로 진행이 되었다. 먼저 정서조절전략에 대한 지시 없이 부정적 정서 유발 영상을 본 후 통증 표정에 대한 주의편향이 측정되었으며, 두번째는 정서조절전략에 대한 지시를 한 후 부정적 정서 유발 영상을 본 후 통증 표정에 대한 주의편향이 측정되었다. 실험결과, 정서적 억제를 사용한 만성통증 집단은 정서 재평가를 사용한 만성통증 집단에 비해 통증 표정을 더 오랜 시간 보았으나, 비통증군에서는 정서조절 조건에 따른 유의한 차이는 보이지 않았다. 이러한 결과는 정서조절전략으로 정서적 억제를 사용하는 만성통증자들이 통증 관련 자극에 대해 주의를 더 많이 기울인다는 것을 알 수 있다.

주요어: 만성통증, 정서조절, 인지적 재평가, 정서적 억제, 주의편향, 통증 강도, 부정적 정서성