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The effects of acceptance and suppression on anticipation and receipt of painful stimulation

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ABSTRACT

Background and objectives: Previous research has found that in some contexts, suppression increases distress, whereas acceptance decreases distress. It is not clear, however, whether these two common forms of emotion regulation have comparable or divergent physiological and behavioral effects during the anticipation and receipt of a painful stimulus.
Methods: To address this issue, we randomized participants to suppression, acceptance, or no instruction control groups, and assessed their cardiovascular and behavioral responses while they anticipated and then received electric shocks.
Results: Findings revealed that compared to the control condition (1) acceptance and suppression led to comparable reductions in pain reports and cardiac defense responses; and (2) acceptance led to greater reductions in reports of anticipatory anxiety than suppression.
Limitations: The current study tested only two emotion regulation techniques in the context of a pain-inducing stimulus that has limited ecological validity.
Conclusions: In contrast to previous research, we found that both acceptance and suppression are effective in reducing pain and anxiety in response to experimentally induced pain.

1. Introduction

Pain is an inevitable part of life. If that is the bad news, the good news is that there are numerous strategies for regulating pain and the negative emotions that are associated with the anticipation and experience of pain (e.g., Hayes, Strosahl, & Wilson, 1999, p. 304; Masedo & Esteve, 2007). These strategies have quite different profiles of costs and benefits, and a growing literature has begun to explore the emotion regulation strategies employed to regulate unpleasant emotions (Dan-Glauser & Gross, 2011) and physical sensations (Masedo & Esteve, 2007).

1.1. Suppression

One commonly used regulation strategy is *suppression*, which refers to the intentional inhibition of expressive (Miles & Gross, 1999) and/or experiential (Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Feldner, Zvolensky, Eifert, & Spira, 2003; Masedo & Esteve, 2007) aspects of one's ongoing affective responses. Empirical research yields an inconsistent picture of the effects of regulating during emotion-eliciting but non-pain related stimuli. Suppression has been shown to (a) decrease (Dunn, Billotti, Murphy, & Dalgleish, 2009; Goldin, McRae, Ramel, & Gross, 2008), (b) increase (Dalgleish, Yiend, Schweizer, & Dunn, 2009; Dan-Glauser & Gross, 2011), or (c) have no effect (Gross & Levenson, 1993; Roberts, Levenson, & Gross, 2008) on emotional experience, but (d) lead to increases sympathetic nervous system activation (Campbell-Sills et al., 2006; Gross & Levenson, 1993, 1997; Gross, 1998, 2002; Hofmann, Heering, Sawyer, & Asnaani, 2009). In the context of pain, suppression seems to paradoxically increase pain and distress in response to thoughts about or presentation of a pain-inducing stimulus (e.g., Sullivan, Rouse, Bishop, & Johnston, 1997). A recent meta-analysis found that suppression is associated with psychopathology such as anxiety and depression (Aldao, Nolen-Hoeksema, & Schweizer, 2010). It should be noted, though, that different definitions of suppression are used in different experiments, some use solely expressive suppression, whereas others use suppression of emotional feelings or a combination of both. It appears from the literature that suppression has quite variable effects depending on context, regulation target, and individual differences.

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1.2. Acceptance

A second regulation strategy is *acceptance*, which refers to the welcoming of thoughts, emotions, and other experiences in the moment, with non-evaluative judgment (Thompson, Arnkoff & Glass, 2011; Erisman & Roemer, 2010; Hayes, Strohsahl & Wilson, 1999, p. 304; Hayes, 2004). Empirical research has demonstrated that acceptance: (a) successfully decreases unpleasant emotional experience, especially in conditions of high stress (e.g. Eifert & Heffner, 2003; Feldner et al., 2003; Levitt, Brown, Orsillo & Barlow, 2004); and (b) is associated with decreased anxiety and depressive symptoms over time (Shallcross, Troy, Boland, & Mauss, 2010; Veehof, Oskam, Schreurs & Bohlmeijer, 2011). In the context of pain, acceptance has been found to be associated with decreased pain and distress in response to thoughts about or presentation of a pain-inducing stimulus (e.g., Hayes et al., 1999, p. 304).

1.3. Suppression versus acceptance in the context of pain

Both theory and empirical research suggest the value of directly comparing suppression and acceptance in the context of pain. Theoretically, suppression has been conceptualized as falling on the opposite end of a continuum of experiential avoidance from acceptance (Hayes, Jacobson, Follette, & Dougher, 1994; Hayes, Wilson, Gifford, Follette & Strosahl, 1996). Empirically, research suggests that suppression should lead to either increases or decreases in unpleasant emotions, and increases in pain (Dan-Glauser & Gross, 2011; Gross & Levenson, 1997; Sullivan et al., 1997), whereas acceptance should lead to decreases in both unpleasant emotions and pain (Feldner et al., 2003; Hayes et al., 1999, p. 304).

To our knowledge, only one study has directly compared the use of suppression and acceptance to regulate responses to pain. Masedo and Esteve (2007) found that a group using suppression to regulate pain showed the lowest tolerance level of pain as expressed in immersion time in cold water during a cold pressor task. The group using an acceptance based strategy exhibited the longest immersion time. Also, the acceptance group reported significantly lower levels of pain and distress than the suppression group. This study did not measure physiological arousal, which is important given discrepancies between self-reported and physiological arousal in participants using suppression (e.g., Campbell-Sills et al., 2006; Gross & Levenson, 1993, 1997). Also, in this study anticipatory anxiety was not explicitly assessed. In as much as pain and anticipatory anxiety have been closely linked in theory (e.g., Aldrich, Eccleston, & Crombez, 2000) and research (e.g., Ocañez, McHugh, & Otto, 2010; Colloca & Benedetti, 2007), it is important to investigate factors that could potentially influence this relation, such as emotion regulation.

1.4. The present research

The present study is the first to directly compare differences in pain, anxiety, and associated physiology (i.e., heart rate) between groups using suppression versus acceptance regulation strategies, or a no regulation strategy (i.e., control group) in response to experimentally induced pain. All groups started with a spontaneous coping block and then received instructions on how to regulate their responses in the second block. Participants were instructed to either accept, suppress or received no instructions how to regulate their responses. Comparing the unregulated block to the regulated block, we hypothesized that (1) acceptance would lead to the greatest reduction in pain compared to the suppression group and the control group, for the latter we expect no reduction in pain; (2) acceptance would lead to the greatest reduction in anxiety compared to the suppression and the control group; and (3) acceptance would lead to less heart rate reactivity than in either the suppression or control groups. In regard to the last hypothesis, the suppression group was expected to show elevated responses relative to both other groups.

2. Methods

2.1. Participants

One hundred and twenty-three college students and members of the general public (53.7% males; $M_{age} = 21.7$ years, $SD_{age} = 5.1$) enrolled in this study. All participants signed informed consent prior to participation. They received course credit or $20 for participation. This study was approved by the Stanford University Institutional Review Board.

2.2. Procedure

After informed consent, participants were fitted with measurement sensors and shock electrodes on the right lower arm. During a stepwise work-up procedure participants gradually increased shock intensity to a level they described as 'unpleasant and demanding some effort to tolerate, but not too painful' (Drabant et al., 2011).

The task consisted of two blocks with 5 trials each. Each trial consisted of a preparation (5s), anticipation (15-18s), shock delivery, rating, and inter trial interval (ITI, 18–21s) phases. Anticipation duration was varied and two trials with early shocks were inserted (but discarded from analyses) to create the impression of unpredictability. Following each shock, participants rated physical *pain* (0 = "not unpleasant at all" to 100 = "extremely unpleasant"[4]), and pre-shock *anxiety* (0 = "not anxious at all" to 100 = "extremely anxious"). Behavioral ratings for pain and anxiety were averaged across blocks. Twelve participants who reported very low anxiety (<15) during the unregulated block were excluded from all analyses.[5]

For all participants, the first block was an uninstructed block. Then, before the second block, the experimenter delivered instructions according to randomized group assignment. The *suppression* group was instructed to "fully control and resist any feelings and behavioral responses" they might have, and not "let any emotions show on their face". The *acceptance* group was instructed to "fully experience and accept any feelings and responses" they might have without "trying to control, avoid, resist or change" them (Hofmann et al., 2009). The *control* group did not receive any instructions about how to regulate their emotions in the second block.

At the end of the session, a manipulation check questionnaire asked participants to indicate which regulation style (acceptance, suppression) they had actually used during the second block. Thirteen participants (12 in suppression, 1 in the acceptance group) were excluded since they reported spontaneously switching to the opposed regulation strategy (suppression to acceptance and vice versa) leaving 33 participants in both the acceptance and suppression group, respectively, and 32 in the control group.

2.3. Apparatus and data reduction

Electric shocks (200 ms) were delivered to the right wrist with a Grass (West Warwick, RI) SD9 square pulse stimulator. A lead-I

[4] Due to ethical considerations, we used the term "extremely unpleasant" instead of "painful" as scale anchor.

[5] These participants (7 in the suppression group and 5 in the control group) evidenced floor effects in the regulated block and were considered to have experienced too little anxiety to test for regulation. Including these participants in the analyses did not change the pattern of results.

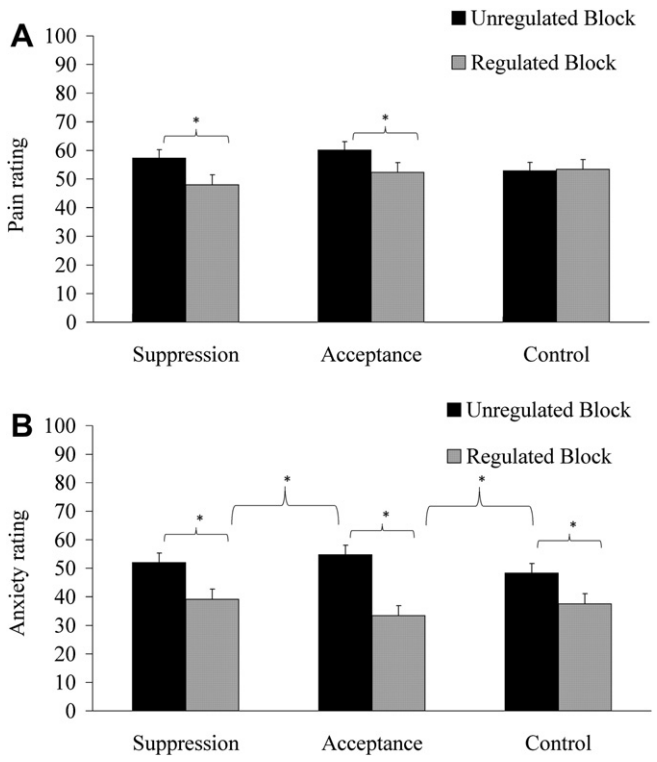

Fig. 1. Means and standard errors for pain (Panel A) and anticipatory anxiety (Panel B) ratings across groups for regulated and unregulated blocks.

electrocardiogram (ECG) was recorded continuously at 500 hz.[6] Offline, R-spikes were detected, artifacts rejected, and heart period (HP) time series derived. Evoked HP responses were derived by subtracting the average of a 2-s pre-trial baseline from each 1-s mean during the trial. Response scores comprised mean HP response during the preparation (5 s), the anticipation (variable between 15 and 18 s), and shock phases (8 s following the shock). All calculations were based on HP (Quigley & Bernston, 1996), but HP was converted to heart rate (HR) in Tables and Figures. Four participants were excluded from the HP analysis due to artifactual or arrhythmic ECG.

3. Results

3.1. Pain ratings

A 2 (Block: uninstructed, instructed) × 3 (Group: acceptance, suppression, control) repeated measures ANOVA revealed a significant main effect for Block, $F(1,95) = 12.6$, $p = .001$, $\eta^2 = 0.117$ and a significant Block × Group interaction, $F(1,95) = 3.82$, $p = .025$, $\eta^2 = 0.074$ but no main effect of Group $F < 1.00$. Within groups, post-hoc t-tests indicated significant decreases in pain ratings when comparing the unregulated with the regulated block in both regulation groups, $t(32) = 2.41$, $p = .022$, $d = 0.852$, and $t(32) = 3.53$, $p = .001$, $d = 1.267$, but not in the control group, $t < 1.00$, ns., see Fig. 1A. As expected, the acceptance group showed greater reductions in pain relative to the control group. However, contrary to our hypotheses, suppression was associated with a similar decrease in experienced pain as acceptance.

[6] Electrodermal activity was recorded, but amplifier saturation corrupted the data. Blood pressure measures were also acquired but did not discriminate between groups.

3.2. Anxiety ratings

A similarly structured 2 × 3 ANOVA for anticipatory anxiety ratings revealed a Block main effect, $F(1,95) = 84.6$, $p < .001$, $\eta^2 = 0.471$, and a significant Block × Group interaction. $F(2,95) = 3.99$, $p = .022$, $\eta^2 = 0.077$, but no Group main effect $F < 1.00$, ns. Within groups, post-hoc t-tests indicated significant decreases in anxiety ratings when comparing the unregulated with the regulated block in all groups (all $ts > 4.28$, $ps < 0.001$, $d > 0.766$). However, a difference score (unregulated block - regulated block) revealed stronger reductions in the acceptance group than in the suppression group, $t(64) = 2.03$, $p = .046$, $d = 0.507$ and the control group, $t(63) = 2.60$, $p = .012$, $d = 0.655$. Suppression and control groups did not differ, $t < 1.00$, see Fig. 1B. These results indicate that anxiety was reduced for all groups in the second block. However, in accordance with the hypothesis the reduction for the group using acceptance was significantly higher than for the other groups.

3.3. Heart rate responses

A 2 (Block: uninstructed, instructed) × 3 (Group: acceptance, suppression, control) × 3 (Period: preparation, anticipation, shock) repeated measures ANOVA for HP-responses yielded a 3-way interaction, $F(4,180) = 3.01$, $p = .024$, $\eta^2 = 0.063$ in addition to Period and Block main effects, $Fs > 11.0$, $ps < 0.003$, Group: $F < 1.00$. Within groups, post-hoc t-tests located this interaction in decreased shock responses in the regulated compared to the unregulated block in the acceptance, $t(30) = 3.34$, $p = .002$, $d = 0.543$, and the suppression group, $t = 3.38$, $p < .001$, $d = 0.811$, but not in the control group, $t(30) = 1.22$, $p = .231$, see Table 1 and Fig. 2. No group differences were evident for the preparation and anticipation phase. Contrary to the hypothesized reduction for acceptance only, these results show that heart rate defensive responding was reduced in both regulation groups, but not in the control group.

4. Discussion

The present study aimed to contrast the theoretically opposing regulation techniques, acceptance and suppression, during the regulation of the anticipation and delivery of painful stimuli. Results indicated similarities as well as differences between strategies. Partially consistent with our hypothesis that acceptance would result in the greatest reduction in pain as well as anxiety, results showed that both regulation techniques decreased pain as well as anxiety and heart rate defensive responding (Öhman, Hamm, & Hughdahl, 2000; Sokolov, 1963). However, anxiety was significantly more reduced for the group using acceptance. These results are partly consistent with previous findings but differ in important ways. Results and implications for future research for both regulation techniques will be discussed below.

4.1. Suppression

Contrary to our prediction, but consistent with previous research (Dunn et al., 2009; Goldin et al., 2008), we found that the

Table 1
Means and standard errors of heart rate responses across groups during preparation and anticipation.

	Acceptance	Suppression	Control
Preparation unregulated	0.92 (0.55)	2.97 (0.56)	1.95 (0.55)
Preparation regulated	1.56 (0.55)	1.94 (0.55)	1.70 (0.54)
Anticipation unregulated	−1.85 (0.62)	−1.63 (0.63)	−1.70 (0.63)
Anticipation regulated	−2.96 (0.68)	−2.29 (0.68)	−2.13 (0.68)

Note. See Fig. 2 for heart rate responses to shock.

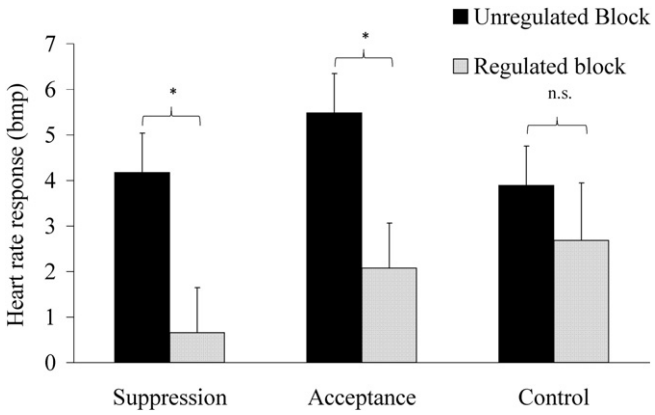

Fig. 2. Heart rate responses and standard errors to shock during unregulated and regulated blocks across groups. See Table 1 for preparation and anticipation values.

use of suppression significantly reduced anxiety. Additionally, and in contrast to previous research (Gross & Levenson, 1993, 1997; Masedo & Esteve, 2007; Sullivan et al., 1997), we found that suppression significantly reduced pain and cardiac defense responses. In regard to pain it has been found in prior studies that suppression is not effective in reducing pain (Cioffi & Holloway, 1993). The results of this study indicate that suppression may, in some cases, be an effective regulation technique for pain. In regard to cardiac defense responses, it has been found that suppression is associated with 'physiological costs' such as increased heart rate during social stress (Hofmann et al., 2009) whereas other research has showed variable effects of (expressive) suppression on heart rate but increased sympathetic nervous system activity (pulse transit time and skin conductance level) during exposure to disgust-eliciting films (Gross, 1998; Gross & Levenson, 1993). In contrast, our results suggest that in the context of anticipating and experiencing pain, suppression may be beneficial at reducing somatic sensations and associated emotions without physiological costs, at least in some contexts.

4.2. Acceptance

Consistent with our hypotheses and previous research (Feldner et al., 2003; Hayes et al., 1999, p. 304; Masedo & Esteve, 2007), we found that the use of acceptance significantly reduced anxiety, pain, and cardiac defense responses, and there were stronger reductions in anxiety in acceptance versus suppression or control groups. This underscores the power and utility of this emotion regulation strategy and makes it a promising target for treatment of pain in applied settings.

However, our finding that suppression and acceptance were *both* associated with decreased pain conflicts with results by Masedo and Esteve (2007) who found that only the use of acceptance lowered pain and distress. This difference could be due to differences in stimulus type (cold pressure vs. electric stimulus) or stimulus duration. The cold pressor task used by Masedo and Esteve (2007) is a continuous painful stimulus of longer duration than the shock stimuli used here. Suppression and acceptance may be equally beneficial at reducing pain for short-duration stimuli. However, for long duration stimuli, suppression may lead to paradoxical increases in pain whereas acceptance continues to reduce pain.

More generally, it is possible that inconsistent findings of previous research with regard to physiological cost of suppression might be related to stressor length. Film watching (e.g. Gross, 1998), public speech (Hofmann et al., 2009) and cold pressure testing (Masedo & Esteve, 2007) involve long duration stimuli/stressors requiring participants to continuously monitor emotional expressions and feelings with the result of increased physiological responses. Here, very brief pain stimuli (and their anticipation) were not associated with such physiological costs. Acceptance on the other hand is potentially more easily achieved and maintained throughout the task. Therefore, acceptance may be a particularly promising strategy for long-duration stressors. One way to investigate this would be to use a within-subject study in which participants suppress or accept both short and longer stimuli durations.

4.3. Limitations and future directions

Although the findings of this study have important implications for the pain and emotion regulation literature, this study has notable limitations.

First, to assess anticipatory anxiety, we used a post-event self-report measure. The anxiety ratings may have been influenced by the electrical stimulation. However, continuous ratings (Drabant et al., 2011) have the disadvantage of requiring attentional resources that could otherwise be used for following instructed emotion regulation. In the future, it will be useful to combine retrospective and continuous rating methods.

Second, this study focused on a single task context. The brief pain stimulus used in the current experiment might resemble brief pain sensations such as experienced with needle penetrations, but this type of pain is not typically experienced in daily life. This limits the applicability of the current findings to real life stress and emotional experience. To investigate the benefits of emotion regulation in daily life situations, future research could investigate the effects of these and other forms of emotion regulation before and during naturally occurring pain episodes (e.g., back or headaches). In this regard, the temporal dynamics of regulation may be important: while suppression might work well for brief painful stimuli (as used here), more continuous pain sensation might reveal a different pattern (cf, Shallcross et al., 2010). Future research can also explore the possibility that suppression of a continuous stressor versus a relatively brief, event-related stressor results in different effects. We posit that the latter requires less metabolic and mental resources, and thus is associated with less physiological costs.

Third, as noted above, we excluded 12 participants who spontaneously switched from using suppression to acceptance. This switch may have occurred because acceptance was more appealing to these participants than was suppression. Future research can the role of preferences by using experimental paradigms in which participants choose which emotion regulation strategy they will implement to regulate pain (cf. Sheppes, Scheibe, Suri, & Gross, 2011) or use a within-subject design in which participants flexibly use different emotion regulation techniques (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004). This type of setting would also facilitate the investigation of individual differences in preferred emotion regulation style. These individual differences may influence the efficacy of instructed emotion regulation, such that individuals who have for instance suppression or avoidance as their preferred emotion regulation strategy will find it more difficult to follow instructions to accept than individuals who have acceptance as their preferred emotion regulation strategy and vice versa.

Conflict of interest

The authors declare no conflict of interest.

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