THE IMPACT OF WRITTEN EMOTIONAL DISCLOSURE ON LABORATORY INDUCED PAIN

A Thesis

by

SUZANNAH KATHLEEN CREECH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2004

Major Subject: Psychology

THE IMPACT OF WRITTEN EMOTIONAL DISCLOSURE ON LABORATORY INDUCED PAIN

A Thesis

by

SUZANNAH KATHLEEN CREECH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Approved as to style and content by:

Mary W. Meagher (Chair of Committee)	James W. Grau (Member)
Colin F. Allen (Member)	Heather Bortfeld (Member)

W. Steven Rholes
(Head of Department)

August 2004

Major Subject: Psychology

ABSTRACT

The Impact of Written Emotional Disclosure on Laboratory Induced Pain. (August 2004)

Suzannah Kathleen Creech, B.A., The University of Texas at Austin

Chair of Advisory Committee: Dr. Mary Meagher

Previous research has demonstrated the impact of negative emotional states on pain modulation. The direction of this modulation has been shown to correspond to the arousal level and the valence of the emotional state, whether naturally occurring or induced in the laboratory. Other research has consistently linked written emotion disclosure of trauma to better long-term health outcomes among several populations. As most of these studies have focused on long-term health outcome effects of disclosure, little research has been done on the immediate effects of the paradigm on affective or physiological states. This study investigated the short-term effects of written disclosure of trauma on laboratory-induced pain, affective state, and other physiological measures of stress and arousal. Other goals of the study included investigating preexisting differences in pain sensitivity between participants corresponding to lifetime experience of trauma, and determining the degree to which baseline pain testing alters pain sensitivity after emotion induction by creating a conditioned, contextual fear. This is the first study to apply the written emotional disclosure paradigm to laboratory-induced pain.

TABLE OF CONTENTS

Page

INTRODUCTION

Background

A growing body of research has demonstrated the significant role emotion plays in pain modulation. A similarly large amount of research has linked written emotional disclosure of trauma to better long-term health outcomes. To date, however, few studies have looked at the impact of written disclosure of trauma on pain populations, and no studies have examined its effect on laboratory pain. Similarly, few studies have examined the acute affects of written emotional disclosure. The current paper will briefly discuss the role of negative affect in pain modulation. It will then discuss the written emotional disclosure paradigm and a study intended to examine the acute effects of written disclosure of trauma on laboratory-induced pain.

Pain and Emotion. The experience of pain is not simply determined by the intensity of nociceptive stimulation; it also depends on the individual's emotional and motivational state. As such, pain is not the end product of a linear sensory transmission system, but is a dynamic process which involves continuous interactions among complex ascending, descending, and central-systems which can be affected by emotion, stress, and even prior activation of neural structures (Melzack and Katz, 1990).

The first model to integrate physiological and psychological variables that contribute to pain was the *gate control theory* (Melzack and Wall, 1965). The *gate control theory* of pain is a multi-dimensional model that conceptualizes pain as the integration of motivational-affective, cognitive-evaluative, and sensory-physical

---

This thesis follows the style and format of *Psychological Science*.

components. According to this theory, the dorsal horn of the spinal cord acts as a gate which can be opened or closed and thus can inhibit, transmit or enhance pain sensations traveling up the spinal cord to the brain. The brain is then able to send signals down the spinal cord that can either open or close the gate. It is this descending pathway that is thought to be the mechanism through which emotions and cognitions modulate incoming pain signals (Fields, 2000). Negative emotions are theorized to open the gate, allowing amplification of pain signals. Positive emotions are theorized to close the gate, inhibiting pain signals. In addition, emotion may influence the interpretation of the nociceptive signal at the level of the brain through activation of neural structures shared by emotion and pain circuits (Rhudy & Meagher 2001). Though advances in research on the pain modulatory system have led to revision of the physiological details of *gate control theory* (Fields & Basbaum, 1999), the general concepts introduced in the theory retain heuristic value (Turk, 1996).

Emotion induction procedures used in laboratory studies of pain have generally supported the *gate control theory*. One of the most commonly used methods of emotion induction is the International Affective Picture System (IAPS). The IAPS includes over 500 color pictures that evoke both unpleasant and pleasant emotions that vary along the affective dimensions of valence (pleasant-unpleasant) and arousal (calm-aroused). In a recent study, Meagher, Arnau, and Rhudy (2001) examined whether viewing unpleasant, pleasant, and neutral IAPS slides affected male and female participant's experience of cold pain across two experiments. In the first experiment, participants viewed either fear, disgust, or neutral slides immediately before submerging

their arm in a circulating ice water bath (i.e., the cold pressor test). Results indicated that the fear and disgust slides reduced thresholds for pain intensity and unpleasantness compared to neutral slides. However, only the fear slides induced physiological arousal and reduced pain tolerance. In the second experiment, participants viewed either erotic, nurturant, or neutral images. Erotic slides increased thresholds for pain intensity and unpleasantness in men, while pain tolerance was unaffected. The results suggest that unpleasant emotions may enhance pain while pleasant states may attenuate pain when arousal is high. Similar findings were reported, independently, by de Wied & Verbaten (2001) who presented pleasant, neutral, and unpleasant IAPS pictures to males during the cold-pressor test. Subjects who concurrently viewed the unpleasant images had the lowest pain tolerance, while subjects who viewed the pleasant photos had the highest pain tolerance.

The findings from IAPS affect-induction studies are consistent with prior studies examining the impact of emotional states on cold pain. Zelman and colleagues have shown that pain tolerance was decreased by reading depressive statements and increased by reading elative statements immediately before the cold pressor test (Zelman, Howland, Nichols & Cleeland, 1991). Similarly, other studies report that cold pain sensitivity is decreased by viewing erotic and humorous films (Weisenberg et al., 1998).

When visual and verbal stimuli are used to induce emotion, they do not evoke intense, highly arousing states. To elicit intense emotional responses, researchers present threatening stimuli such as painful electric shocks. Using this approach,

laboratory studies suggest that the negative affective states of intense fear and anxiety have divergent effects on pain perception. For example, Rhudy and Meagher (2000) have shown that fear, established by presentation of mild electrical stimulation, induced hypoalgesia, or decreased pain sensitivity. In contrast, anxiety, established by threat of electrical stimulation without actual presentation, induced hyperalgesia, or increased pain sensitivity. These findings suggest that the impact of negative affect on pain is related to level of arousal; highly arousing negative affect (fear) seems to inhibit pain, while less arousing negative affective states such as anxiety increase pain. Similarly, other laboratories have reported hypoalgesia after exposing PTSD patients to trauma-related stimuli (Pitman et al.,1990), exposing spider phobics to spiders (Janssen & Arntz, 1996), and after a first time parachute jump (Janssen & Arntz, 1999). Taken together, these data suggest that highly arousing negative affect inhibits pain.

In addition to these emotion induction studies, naturally occurring negative affective states such as depression are related to increased pain. Researchers have shown that depressed arthritic patients report higher levels of pain over a 75 day period compared to nondepressed patients (Affleck, Tennen, Urrows & Higgens, 1991). In a similar study Zautra & Smith (2001) examined weekly average levels of arthritis pain, positive and negative interpersonal events (stress level), and negative affect in 188 women diagnosed with rheumatoid arthritis or osteoarthritis. Results indicated that depression was related to increased pain in both groups of subjects. In addition, the researchers found that depressive symptomatology predicted increased stress reactivity and increased pain in the rheumatoid arthritis group, suggesting that depression may act

as a moderator between negative interpersonal events and increased pain.

The findings discussed previously have indicated that both laboratory induced affective states (via shock, IAPS slides etc.) and naturally occurring affective states (like depression) impact pain sensation. Few studies, however, have been able to use a naturally occurring, personal affective state to study its impact on laboratory induced pain. One goal of the current study was to use written emotional disclosure as a personally relevant and more natural method of affect induction.

Written Emotional Disclosure of Trauma. The written emotional disclosure paradigm typically involves having participants write for 20 minutes for three or four consecutive days about a previously undisclosed traumatic experience (Pennebaker & Beall, 1986). A control group usually writes about non-emotional topics such as their plans for the day or their shoes. The written disclosure paradigm has been shown to impact a wide variety of outcome measures, from visits to the health center, disease activity, and even marital stress after infidelity (see Smyth, 1998 and Sloan & Marx, 2004 for a review; Snyder, Gordon & Baucom, 2004). A recent meta-analysis of all written emotional expression studies yielded a significant Cohen's d of .47, a 23% improvement in the experimental group over the control group (Smyth, 1998).

Indeed, the written disclosure paradigm has been used with much enthusiasm in the last ten years, and there has been a major push to extend and determine both its utility as a therapeutic tool (Lepore & Smyth, 2002; Snyder, Gordon & Baucom, 2004), and what is known about the mechanisms whereby it has achieved it effects (Kloss & Lissman, 2002; Sloan & Marx, 2004). Many have questioned the nature of the cognitive

changes that are assumed to drive the affective and physiological changes that have been observed (see Sloan & Marx, 2004 for a review). Pennebaker originally suggested that inhibition of a trauma elicits increased short-term autonomic nervous system activity and leads to constant long-term low level stress (Pennebaker & Susman, 1988). Pennebaker suggested this stress might activate the Behavioral Inhibition System, which leads to immunosuppression and poor health. Disclosing a trauma, then, could be seen as a release from inhibition, that could consequently lead to improved health. However, as Littrell (1998) notes, there is little physiological evidence linking emotional inhibition to activation of the Behavioral Inhibition System. This has led other researchers to argue that the mechanism behind the observed effects does not involve a release from inhibition, but rather involves the cognitive restructuring of memory, or alternatively, exposure and emotional processing (Littrell, 1998; Sloan & Marx, 2004).

Though the long-term effects of written disclosure are important to investigate, until very recently the literature in this area has failed to investigate the acute and immediate effects of this paradigm on subjective and objective measures of affect and arousal, which may act as the mediators of the effect. Until this can be determined, the mechanisms of the overall effect can only be speculation; therefore, another goal of the current study included investigating the short-term effects of written emotional disclosure on laboratory-induced pain, affective state, and other physiological measures of stress and arousal.

This study took place over two-days and included one day of writing for twenty minutes. On the first day, participants either received instructions only, or

instructions plus baseline pain testing. On the second day, all participants wrote for 20 minutes about a trauma or neutral topic, which was followed by pain testing. Participants also completed subjective measures of affect and arousal, and physiological measures of heart rate and skin conductance were taken throughout.

The baseline testing group was included to allow within-subject comparisons between baseline pain sensitivity and pain sensitivity after writing about trauma. The instructions only group was included to address concerns about how baseline pain testing might affect the writing procedure and later testing by inducing a conditioned fear to the context. Conditioned contextual fear is a concept that comes out of studies on the learning mechanisms involved in conditioning, and more specifically, in conditioned fear. These studies have shown that when an aversive stimulus is paired with a previously neutral cue, both animals and humans later experience a conditioned fear when only the cue is present, i.e. the neutral cue becomes a conditioned stimulus (Fanselow, 2000; Fendt & Fanselow, 1999). When considering pain testing, it is important to note that these same processes may be engaged. The context in which pain testing occurs (the testing room and its contents) may be considered as a broad neutral cue prior to pain testing, however, during pain testing, the context (CS) becomes associated with the aversive pain (US). After pairing the context (CS) with the pain (US), exposure to the context elicits a conditioned fear state (CR) in participants when they return to the room on day two. Importantly, research has shown conditioned fear induces analgesia (decreased pain sensitivity), therefore it is important to have a group that does not receive baseline pain tests (Faneslow & Baakes, 1982). The extent to

which the baseline group shows analgesia on the second day of testing may be an indicator of whether conditioned contextual fear has occurred, and this will determine whether a within-subjects or between-subjects analysis can be used in subsequent studies. In this study, the differences in pain sensitivity, affective response, and physiological arousal between the baseline and no baseline groups were widespread, suggesting that prior pain testing had a profound effect.

In order to be consistent with Pennebaker's work, participants were also either positive or negative for lifetime history of trauma. Research has shown heightened tonic physiological arousal in PTSD victims (Blanchard, 1990; Blanchard, Kolb, Gerardi, Ryan & Pallmeyer, 1986), therefore the no lifetime history of trauma group was included to help account for any pre-existing differences in physiological and affective reactivity between traumatized and normal participants.

It was hypothesized that writing about the trauma topic would induce increased levels of negative affect and arousal on both subjective and physiological measures when compared to the neutral writing condition. Accordingly, it was hypothesized that participants who wrote about the trauma topic would show increased pain sensitivity, or hyperalgesia, relative to control participants who wrote about time management. It was further hypothesized that baseline pain testing on day one might influence writing and testing on day two by creating a conditioned fear to the context; therefore participants who completed baseline testing might show analgesia. Finally, it was hypothesized that trauma history and no-trauma history participants might differ in physiological and affective reactivity both before and after the writing procedure.

METHODS

Participants

Approximately 1700 undergraduate introductory psychology students were pre-screened for traumatic experiences and corresponding levels of disclosure on the Childhood Trauma Questionnaire in the spring, summer and fall semesters of 2003 (CTQ;Pennebaker & Susman, 1988). All participants received course credit toward fulfilling requirements for their introductory psychology course.

The Childhood Trauma Questionnaire is a 13-question survey of 6 early traumatic experiences (death, divorce, violence, sexual abuse, illness, or other) and ratings of the degree to which individuals confided the traumas. Participants answer yes or no to traumatic experiences and then rate how traumatic the experience was on a 1-7 point likert scale (1 = not at all traumatic, 7 = extremely traumatic). If the participant answers yes to having experienced the trauma, they also rate the degree to which they confided in others about the traumatic experience on a 1-7 point likert scale (1 = not at all, 7 = a great deal). In order to be consistent with Pennebaker's methodology, participants with high levels of traumatic experiences but low levels of disclosure of those experiences were chosen.

Approximately 110 female students in good health were included as trauma history or no trauma history participants based on these prescreening trauma scores. Participants qualified for the trauma history condition if their summed trauma score minus summed disclosure score was two standard deviations above the mean. The mean trauma history score for included trauma history participants was 11.11, SD= 5.92.

Participants were placed in the no trauma group if their summed trauma score minus summed disclosure score was two standard deviations below the mean. The mean trauma history score for included no trauma history participants was .09, SD= 2.17. Of the 110 participants who disclosed an ethnicity, 80% were Caucasian, 6% were Latin American, 6% were Asian, 6% were African American, and 2 % were Hispanic. Three students chose not to disclose their ethnicity.

Based on responses on the Health Status Questionnaire, a brief survey of health problems given during prescreening, any participants taking psychotropic medications or indicating a history of circulatory, neurological, or cardiovascular disorders were excluded from the study. In addition, any participants who failed to follow instructions or scored two or more standard deviations from the mean on certain tests were excluded from analyses of data from those tests. Specifically, thirteen participants were excluded from analysis of radiant heat test data because two or more of their withdrawal latencies were 2 standard deviations above or below the group mean. In addition to 8 other participants who had scores two standard deviations above or below the group mean, these same 13 participants were excluded from analysis of constant heat data They could not be included because the constant heat stimulus was calculated from an average of the second and third radiant heat trials, and one or both of these values was inaccurate for each of these participants. Thirteen participants were also excluded from analyses of data from the tourniquet test due to equipment malfunction or failure to follow instructions.

Apparatus and Physiological Recording

Physiological Recording. All physiological data were collected using a Grass Instruments Model 7E Polygraph with Model 7DA driver amplifiers; preamplifiers were Model 7P8 and Model 7P1 for heart rate. Data acquisition was computer controlled by LabVIEW software and an AT-MIO-16DL DAQ board (both by National Instruments). Heart rate was measured using a Grass Instruments pulse transducer (Grass PPS) attached to the distal digit of the index finger of the non-dominant hand. Skin conductance level (SCL) was recorded via two sensors attached to the palmar surface of the middle segments on the index and middle fingers of the hand. Both heart rate and skin conductance were sampled at 50 Hz, for 1 min prior to each pain test, as well as before and after the writing period, and number of beats per minute (BPM) was calculated. In addition, average GSR was calculated, and these values were subtracted from one another to calculate change scores. However, forty GSR recordings are not included in analyses due to an undetected equipment malfunction resulting in invalid GSR recordings. GSR and heart rate recordings were also not included in analyses for the tourniquet procedure for the same reason.

Radiant Heat Threshold Test. Pain thresholds were assessed by measuring the time taken to withdraw the finger from a radiant heat stimulus (temperature = 43.5 degrees centigrade). Participants were asked to withdraw their finger (distal phalanx of the index finger on the left hand) *as soon as* they first felt pain. Participants were told that we were interested in determining the point when the stimulus became uncomfortable, not how long they could expose themselves to the stimulus. A movie

light provided the radiant heat source that was focused onto a 2 cm region of the finger. Lateral movements of the finger were detected by a photocell (positioned below the finger embedded within the aluminum finger platform), which recorded the withdrawal latency and terminated the stimulus. An automatic cut-off of 8 sec was used to prevent tissue damage. After a practice trial, 2 baseline pain threshold tests were assessed and averaged using this methodology.

Constant Heat Subjective Pain Rating Test. The average withdrawal latency from radiant heat testing was used to calculate the duration for the constant stimulus pain test. Participants were asked to rate the perceived intensity and unpleasantness of constant duration suprathreshold stimuli using a visual analog scale (VAS). The constant heat test required participants to keep their finger on the heat source until it was turned off by the computer. Participants received a heat stimulus 20% longer than their average withdrawal (i.e., suprathreshold) presented on three fingers of the right hand (index, middle, and ring). Participants completed two sets of constant stimulus tests.

Tourniquet Test. Following constant stimulus testing, pain sensitivity was assessed using the tourniquet procedure (Fillingim et al., 1997). The tourniquet procedure involves the placement of an inflated blood pressure cuff (240 mmHg) on the participant's arm while they perform 20 handgrip exercises at 20% of their maximum. After the 20 handgrips, participants were instructed to leave the cuff on until they reached tolerance. Participants were asked to use the VAS to report when the exercises became painful (pain threshold) and to stop when they reached their tolerance threshold. The procedure was terminated at the point of tolerance or after 25 minutes, which ever

came first. Participants only received 1 tourniquet trial.

Mechanical- Visual Analogue Scale Pain Ratings. Participants were asked to rate both their sensory and affective level of discomfort during the constant heat tests and tourniquet test using a Mechanical Visual Analogue Scale (M-VAS). The M-VAS is used to assess subjective ratings of the sensory intensity and unpleasantness of the stimulus by using line length to represent the magnitude of the subjective state. The endpoints correspond to numbers and verbal descriptors (e.g., 0= not at all unpleasant, while 10 = most unpleasant imaginable). An M-VAS is a physical instrumentation of a pencil and paper visual analog scale consisting of a 100-mm line. Participants move a sliding lever along the line to indicate their pain ratings. This sends a proportional voltage to the computer indicating when pain threshold has been reached and each time the participant's pain changes.

Procedure

Qualifying participants identified through the prescreening process received email notification of qualification and phone calls for scheduling. Two research assistants not included as experimenters were used for scheduling to protect confidentiality of participants. Both schedulers adhered to a written protocol for phone conversations with participants.

Figure 1 depicts the experiment timeline and the 3 pain measures that were taken, including the radiant heat radiant heat withdrawal test, radiant heat constant stimulus subjective pain rating test, and the tourniquet procedure. The study took place over 2 days and included either instructions only or instructions plus baseline pain

testing on day 1, and one writing session plus pain testing on day 2. Participants were randomly assigned to conditions within their trauma group (trauma history or no trauma history); these conditions were: (1) baseline pain testing on day 1 of the experiment (baseline testing or no baseline testing), and (2) writing topic (traumatic or neutral) on day 2 of the experiment.

Day One. On day one all participants were escorted into the experiment chamber for an explanation of procedures and informed consent. In order to avoid expectancy effects, participants were informed we were interested in physiological reactivity. Participants were asked to sign the informed consent and then complete the Center for Epidemiological Study-Depression Scale (CES-D), Health Status Questionnaire, Pennebaker Inventory of Limbic Languidness and Fillingim's General Health Questionnaire (about 20 minutes). After completing these questionnaires participants either received instructions for pain testing or received instructions and completed baseline pain testing. The instructions only group was told " now I am going to familiarize you with tests we will do tomorrow …." Baseline skin conductance and heart rate was taken for all participants. Participants in the baseline testing group received instructions for testing and went on to participate in pain testing. All participants were reminded to return the next day.

Because we were interested in the effects of stress on pain reactivity, it was necessary to assess any preexisting emotional distress that may contribute to unwanted group differences. To do so, the Center for Epidemiological Studies-Depression Scale (CES-D; Radloff, 1977), a brief, 20-item questionnaire that taps into depression and

anxiety symptoms was filled out prior to the experiment. Subjects were instructed to read each item and rate the extent to which they felt that way at sometime during the past week.

The Pennebaker Inventory of Limbic Languidness (PILL; Pennebaker, 1982) is a 54-item scale that measures frequencies of various common physical symptoms and sensations. This measure is frequently used in other writing studies to examine health outcome, therefore it was included here.

Day Two. On day two all participants were escorted into the experiment chamber and were asked to complete a "changes in health status" form and CES-D. Baseline heart rate and GSR recordings were taken (about 10 minutes). Participants then received instructions for the writing procedure in accordance with Pennebaker's previously published procedures (Pennebaker & Susman, 1988). Writing prompts were delivered to participants in envelopes to keep experimenters blind. Participants were instructed to open their envelope and begin writing as soon as the door was closed. After 20 min. the experimenter knocked on the door and instructed the participant to stop writing, and to fold up their writing and return it and the prompt to the envelope. Participants then put the envelope in a file drawer and closed it.

Writing prompts were randomly assigned to participants by the primary experimenter. The prompt given to participants in the neutral condition was: What I would like you to write about today is how you use your time. In your writing, I want you to be as objective as possible. I am not interested in your emotions or opinions. Rather I want you to try to be completely objective. Feel free to be as detailed as

possible. In today's writing, I want you to describe what you did yesterday from the time you got up until the time you went to bed. For example, you might start when your alarm went off and you got out of bed. You could include the things you ate, where you went, which buildings or objects you passed by as you walked from place to place. The most important thing in your writing, however, is for you to describe your days as accurately and as objectively as possible.

The prompt given to participants in the trauma writing condition was: What I would like to have you write about today is the most traumatic, upsetting experience of your entire life. In your writing, I want you to really let go and explore your very deepest emotions and thoughts. In addition to a traumatic experience, you can also write about major conflicts or problems that you have experienced or are experiencing now. Whatever you choose to write, however, it is critical that you really delve into your deepest emotions and thoughts. Ideally, we would also like you to write about significant experiences or conflicts that you have not discussed in great detail with others. You might tie your personal experiences to other parts of your life. How is it related to your childhood, your parents, people you love, who you are, or who you want to be. Again, in your writing, examine your deepest emotions and thoughts.

Immediately after writing, GSR and Heart Rate sensors were re-applied, and pain testing began. Pain reactivity was assessed by radiant heat withdrawal latencies to a radiant heat stimulus, followed by a constant heat subjective pain rating test, and a tourniquet test. A small number of participants also completed the cold pressor test but this was removed from the experiment early on to reduce the length of the study. Both

subjective [Self Assessment Manikin (SAM), Mechanical Visual Analogue Scale (M-VAS) and the Positive Affect Negative Affect Scale (PANAS)], and physiological indicators (skin conductance level, heart rate) were assessed to determine whether writing conditions produced distinct emotional states.

The Self-Assessment Manikin (SAM; Lang, 1980) is a measure with two pictogram scales indicating various levels of valence (ranging from "happy" to "unhappy") and arousal (ranging from "excited" to "calm"). Participants were asked to place an "X" on or between any of the figures to indicate their emotional response after writing and after each pain test.

Participants also rated their emotional reaction using the Positive Affect Negative Affect Schedule (PANAS;Watson, Clark & Tellegen, 1988) . The PANAS is comprised of two 10-item mood scales (positive and negative) shown to be highly internally consistent, largely uncorrelated, and stable at appropriate levels over a 2-month time period. Participants are asked to rate each affective descriptor and rate the degree to which they felt that way during and since the last physiological test on a 0 (very slightly) to 4 (very much) point scale. Ratings for the ten positive and ten negative items are summed to gather total scores for positive and negative affect (lowest possible score = 0, highest possible score = 40).

RESULTS

Manipulation Checks for the Writing Procedure

Subjective Affect Ratings. Figure 2 depicts the effects of trauma history and writing topic on SAM arousal (left panel), SAM valence ratings (middle panel), and PANAS ratings (right panel). Although SAM arousal ratings for the trauma writing condition were elevated in comparison to the neutral condition, this difference was not statistically significant, $F(1, 99) = 3.521$, $p = .0636$). However, a significant main effect of writing topic was found for the degree to which participants rated the writing procedure as unpleasant on the SAM valence scale, $F\ (1, 99) = 54.972$, $p < .001$, indicating that participants who wrote about a traumatic experience rated their emotional state as more unpleasant than participants who wrote about a neutral topic. In addition, a significant interaction was observed between writing topic and trauma history on SAM valence ratings, $F\ (1, 99) = 3.813$, $p < .05$. Post hoc mean comparisons indicated that participants with no lifetime history of trauma who wrote about traumatic experiences rated their emotional state as significantly less negative than the trauma history/trauma writing group, $p < .05$.

PANAS ratings of negative affect after the writing procedure parallel the findings for the SAM. Again, a significant main effect of writing topic was observed, $F\ (1, 75) = 31.692$, $p < .001$, indicating that participants who wrote about a traumatic experience rated their emotional state as more negative than those who wrote about a neutral topic. In contrast to the SAM ratings, a main effect of trauma history was observed, $F\ (1, 75) = 10.462$, $p < .01$. This suggests that regardless of writing topic

(neutral or trauma), participants with a history of trauma reported greater levels of negative affect after writing compared to participants with no history of trauma. In parallel to the SAM findings, a significant interaction was observed between writing topic and trauma history on PANAS negative scale ratings, F (1, 75) = 11.183, $p < .01$. Mean comparisons indicated that participants with a history of traumatic experiences who wrote about traumatic experiences reported higher levels of negative affect compared to participants with no trauma history, $p < .05$. All remaining analyses were not significant, $F < 1.5$, $p > .05$.

Physiological Data. Figure 3 depicts the effect of writing topic on skin conductance collapsed across trauma history conditions. An ANOVA conducted on baseline GSR indicated that there were no pre-existing group differences, F (1, 68) = 1.433, $p > .05$). To control for within group variation, GSR samples collected after writing were analyzed as change from baseline scores. A significant main effect of writing topic on GSR change score was observed, F (1, 62) = 5.587, $p < .05$, indicating that writing about a traumatic experience increased sympathetic arousal. When the average GSR scores were analyzed (as opposed to change scores), as expected we observe a significant interaction effect between writing topic and GSR over time (before and after), F (1,61) = 8.719, $p < .01$, indicating a significant increase in arousal for the trauma writing group after writing.

There was also a significant main effect of day one testing on baseline average BPM change scores from day one to day two, F (1, 80) = 4.747, $p < .05$. While baseline BPM for the baseline testing group decreased from day one to day two, baseline

BPM increased for the no baseline testing group. This finding indicates the no baseline participants had an increase in physiological arousal on day two, which may reflect anxiety about completing the writing procedure or pain testing for the first time. No significant changes in BPM were observed based on writing topic or any other independent variable, $F < 1.5$, $p > .05$. Additionally, because this pre-existing group difference was observed, BPM change scores were not used for any other analyses.

In sum, subjective ratings of affect after the writing procedure indicated participants who wrote about the traumatic topic found their emotional state to be more unpleasant and more negative than those who wrote about the neutral topic. In addition, participants with a lifetime history of trauma found the writing procedure to be the most unpleasant. In contrast to subjective ratings for the trauma writing group in which participants indicated the writing procedure was not arousing, galvanic skin response data indicated arousal significantly increased after writing for this group, further indicating a change in mood. Analyses of heart rate data indicated an increase in BPM for the no baseline group when change between day one and day two baseline BPM was analyzed. This increase in physiological arousal may imply an increase an anxiety about the writing procedure and completing pain testing for the first time.

Radiant Heat Testing

The first radiant heat trial is considered a practice and is not included in analysis. The average of the second and third radiant heat trials was used for analysis.

Day One. No preexisting differences in thermal pain reactivity were observed between subjects with and without a history of trauma, F (1, 45) = .121, p = .7293.

Day Two Pain Testing. Figure 4 depicts the effects of writing topic on day 2 radiant heat pain thresholds. An ANOVA revealed that the main effects of writing topic, trauma history and day one condition were not significant, all F's < .10, p > .05. However, a significant interaction effect between day 1 condition (baseline testing or no baseline testing) and writing topic (traumatic or neutral) on day 2 average radiant heat withdrawal latencies, F (1, 92) = 5.478, p < .05. Mean comparisons indicated that within the trauma writing condition, those with no prior history of testing (no baseline group) had significantly shorter pain threshold latencies, when compared to their baseline testing counterparts. In addition, the no baseline/traumatic writing group had significantly shorter pain threshold latencies than the no baseline/neutral writing group.

Figure 5 depicts a second interaction that emerged between day 1 condition (baseline testing or no baseline testing), writing topic (trauma or neutral), and lifetime trauma history (no trauma history or trauma history) on average radiant heat withdrawal latencies, F (1, 88) = 3.983, p < .05. In this case, the no trauma history/trauma writing topic group differed the most from other groups, displaying the shortest withdrawal latencies for the no baseline participants and the longest withdrawal latencies for the baseline participants. Mean comparisons indicated that within the trauma writing condition, the no trauma history/ baseline testing group had significantly longer pain threshold latencies than both the no trauma history and the trauma history sections of the

no baseline group. In other words, this baseline testing/trauma writing group is analgesic compared to both no baseline groups that wrote about trauma. It is also analgesic compared to its own baseline testing/trauma writing group counterparts with a lifetime history of trauma. Mean comparisons further indicated that within the no baseline group, latencies for the no trauma history/trauma writing topic group were significantly shorter than latencies for the no trauma history/neutral writing group, and the trauma history/ trauma writing group. All remaining analyses were not significant, all F's < 1.5, p > .05.

Subjective Affect Ratings. Figure 6 depicts the effects of baseline testing on SAM arousal (left panel), SAM valence ratings (middle panel), and PANAS ratings (right panel). Regardless of writing topic, a significant main effect of baseline testing was observed for SAM arousal and valence ratings F (1, 58) = 9.225, p < .01, F (1, 58) = 6.684, p = .01. Participants who did not undergo baseline pain testing on day one rated their emotional state after day two testing as significantly more excited and more unpleasant than the baseline testing group. A significant main effect of baseline testing was also found for ratings of negative affect on the PANAS, F (1, 58) = 18.081, p < .01. Participants who did not undergo baseline pain testing on day one rated their emotional state after day two testing as significantly more negative than the baseline testing group. All remaining analyses were not significant, all F's < 1.5, p > .05.

Physiological Data. Analysis of GSR averages over time indicated physiological arousal significantly increased for all participants after radiant heat testing, F (3, 156) = 14.127, p < .01. A significant interaction effect between GSR over time

and writing topic, F (3, 156) = 2.690, $p < .05$, indicated arousal increased for the neutral writing group after radiant heat testing (after writing M = 7.369, SD = 2.219, after radiant heat testing M = 8.614, SD = 2.259), but increased even further for the traumatic writing group (after writing M = 8.059, SD = 2.144, after radiant heat testing M = 9.361, SD = 2.017). Though both groups increased in physiological arousal, level of arousal for the traumatic writing group was higher than the neutral writing group both before and after radiant heat testing.

Analysis of heart rate (BPM) data indicated no significant differences based on writing topic. However, BPM were significantly higher for the no baseline testing group after radiant heat testing (M = 77.149, SD = 10.147) when compared to the baseline testing group (M = 72.500, SD = 7.792), F (1, 87) = 6.184, $p < .01$. All remaining analyses were not significant, all F's < 1.5, $p > .05$.

In sum, participants in the no baseline group, those who had no prior pain testing experience, reacted as predicated; participants in this group who wrote about trauma displayed a hyperalgesic response, reaching pain threshold significantly faster than those who wrote about the neutral topic. However, in the baseline testing group, this effect is reversed; participants who wrote about trauma displayed an analgesic response, taking the longest to reach pain threshold. This suggests that prior baseline pain testing may have induced a conditioned fear to the context.

Participants in the no lifetime history of trauma/trauma writing/baseline testing group had the longest latencies to withdrawal, while the no baseline testing counterpart of this group had the shortest latencies. Again, this indicates that baseline

testing interferes with the effects of writing about trauma in participants with no lifetime history of trauma, furthermore it may actually engage other mechanisms that interfere with pain modulation (conditioned contextual fear). However, subjective affect ratings were not elevated for this group, as one might expect if they were in a fearful state. In contrast, the no baseline group rated their mood after radiant heat testing as significantly more unpleasant and more negative than the baseline group, suggesting that prior exposure to testing reduces affective response after a second day of testing. Similarly, physiological data indicated the no baseline group had a higher heart rate after testing than the baseline group, again indicating that arousal may be reduced on a second day of testing.

Constant Stimulus Subjective Pain Rating Test

Day One. No preexisting differences in VAS ratings were observed between subjects with and without a history of trauma, $F < 1.5$, $p > .05$.

Day Two Pain Testing. The constant heat test is a subjective pain rating test divided into 2 sets of three trials. After each trial participants used the M-VAS to rate the intensity and unpleasantness of the stimulation, which remained constant over time. M-VAS ratings indicated participants who wrote about the neutral topic experienced the procedure as significantly more intense and more unpleasant than the trauma writing group. Figure 7 shows participant ratings of the unpleasantness and intensity of the first set of constant tests. Participants who wrote about the neutral topic rated each stimulation in the first set as significantly more unpleasant than the trauma writing group, $F(1,69) = 3.7$, $p < .05$. The same pattern occurred for intensity ratings of the first

set of stimulations; those in the neutral writing group rated each of stimulations as significantly more intense, F (1,80) = 4.958, $p < .05$. This effect did not occur for the second set of stimulations, $F < 1.5$, $p > .05$.

Figure 8 shows two significant interaction effects between trial, day one condition and writing topic that emerged for both intensity (right panel) and unpleasantness (left panel) ratings when they are analyzed all together rather than as sets, F (5, 395) = 3.543, $p < .01$, F (5,300) = 5.356, $p < .01$. Post hoc analyses indicated within the baseline testing group, mean intensity and unpleasantness ratings were higher for participants who wrote about the neutral topic than participants who wrote about the trauma topic, F (5, 200) = 2.276, $p < .05$, F (5,135) = 4.352, $p < .01$. Though not significant, the same trend is observed in the no baseline group, F (5, 205) = 1.997, p = .09, F (5, 175) = 2.243, p = .0756.

Subjective Affect Ratings. There were no significant effects of writing topic, day one condition or trauma history on SAM valence, SAM arousal, or PANAS negative scale ratings for the constant heat testing.

Physiological Data. The six GSR and BPM average values taken before each constant heat test and one GSR and BPM value taken after constant testing were compacted to observe changes in physiological arousal over testing. A significant main effect of GSR over time emerged, F (6, 330) = 26.154, $p < .001$. This indicates physiological arousal increased and decreased as each constant heat test occurred. Mean comparisons indicated significant differences in GSR between the first and second constant tests (before test 1: M = 8.554, SD = 2.142; before test 2: M = 9.170, SD =

2.142), the third and fourth constant tests (before test 3: M = 9.110, SD = 2.125; before test 4: M = 8.758, SD = 2.012) , and between the sixth constant test and after constant testing was completed (before test 6: M = 9.081, SD = 1.996; after testing: M = 7.399, SD = 2.183).

In addition, a significant interaction emerged between writing topic and lifetime trauma history on compacted GSR, $\underline{F}$ (1, 330) = 6.232, $\underline{p} < .01$. This indicates that throughout constant heat testing, mean GSR levels for the no lifetime trauma history group participants that wrote about the neutral topic (M = 9.1, SD = 1.734) were higher than mean GSR levels for no trauma participants who wrote about traumatic experiences (M = 8.4, SD = 2.339). In contrast, mean GSR levels for the group with lifetime experience of trauma who wrote about the neutral topic (M = 8, SD = 2.150) are lower than mean GSR levels for the lifetime experience of trauma group that wrote about the traumatic topic (M = 9.4, SD = 2.167).

Heart rate data for constant heat testing is similar to GSR data, with a significant effect of BPM over time, $\underline{F}$ (6, 300) = .0461, $p < .05$. Mean comparisons here indicated a significant decrease in BPM after constant testing began (before testing M = 75.121, SD = 9.782) and when compared to BPM prior to each test (Before test 2: M = 73.103, SD = 9.373; before test 3: M = 73.172, SD = 8.647; before test 4: M = 73.759, SD = 9.856; before test 5: M = 73.397, SD = 9.628; before test 6: M = 73.276, SD = 9.418).

In summary, both physiological and subjective measurements of affect and arousal indicated that participants who wrote about the neutral topic displayed higher

levels of physiological arousal and rated the procedure as significantly more intense and more unpleasant than the trauma writing group. This is in contrast to predictions as well as to prior radiant heat findings, and could indicate that the constant procedure itself produces arousing negative affect and that any affect induced by the writing procedure was short-lived and overshadowed by the affect induced by this suprathresold pain test. Support for this perspective is provided by a prior study which found that GSR increased as a result of suprathreshold pain testing (Rhudy & Meagher, 2003). Furthermore, the constant procedure may induce affect differently depending on prior emotional state; thus the trauma writing subjects are presumably already in a negative mood may not respond as much as the neutral writing subjects who are presumably in a neutral state.

Tourniquet Test

Day One. No preexisting differences in pain tolerance were observed between subjects with and without a history of trauma, F (1, 47) = .444, p = .5084.

Day Two Pain Testing. There were no main effects of writing topic, baseline testing or trauma history on tourniquet tolerance, all F's < 1.5 , p > .05. However, Figure 9 depicts a significant 3-way interaction effect between day 1 condition (baseline testing or no baseline testing), writing topic (traumatic or neutral), and lifetime trauma history for day 2 tourniquet tolerance, F (1, 89) = 6.197, p < .05. Mean comparisons indicated that within the no baseline/neutral writing condition, those with no prior history of trauma had significantly higher pain tolerance, when compared to those with a lifetime history of trauma. This finding suggests that among participants undergoing the tourniquet test for the first time, and writing about a neutral topic, pre-existing

differences may exist between those with and without a lifetime history of trauma. This no baseline/neutral writing/ no trauma history group also had significantly higher pain tolerance when compared to the baseline testing/trauma writing/trauma history group. In addition, among trauma history participants, the no baseline/neutral writing group had significantly lower pain tolerance when compared to the baseline testing/neutral writing group.

Subjective Affect Ratings. No significant differences emerged for SAM valence ratings after the tourniquet (all F's < 1.5, p > .05), however several significant interactions were observed for the negative rating scale on the PANAS and SAM arousal ratings. Figure 10 depicts SAM arousal ratings after tourniquet testing. Among participants with a lifetime history of trauma who wrote about traumatic experiences, those who did not have baseline testing rated the tourniquet procedure as significantly more arousing than those that did have baseline testing, $F(1, 79) = 4.429$, $p < .05$.

Figure 11 shows the two significant interaction effects that emerged between trauma history and baseline testing (left panel), and trauma history and writing topic (right panel) on participant ratings of negative affect after the tourniquet procedure. Depicted on the left is an interaction between day one condition and lifetime history of trauma on the negative affect scale of the PANAS, $F(1, 67) = 4.226$, $p < .05$. Mean comparisons indicated that those in the baseline testing group with no trauma history rated their emotional state after the tourniquet test as significantly less negative than those in the baseline testing group with a history of trauma. Depicted on the right is the second interaction effect that emerged between writing topic and trauma level on the

negative affect scale of the PANAS, F (1, 67) = 4.996, $p < .05$. Mean comparisons indicated that among participants with a lifetime history of trauma, those who wrote about the neutral topic rated their mood as less negative after the tourniquet test than those who wrote about traumatic experiences. Additionally, among those who wrote about traumatic experiences, those without a lifetime history of trauma rated their mood as less negative after the tourniquet test than those with a lifetime history of trauma.

Taken together, these findings echo those from radiant heat testing; baseline testing seems to cloud the effect of writing about trauma. In this case, there are no significant differences based on writing topic and again, like in the constant stimulus testing, most differences emerged within the neutral writing group. Additionally, in the neutral writing group, lifetime history of trauma seemed to play a significant role, as participants with a lifetime history of trauma show a hyperalgesic response when compared to no trauma history participants.

DISCUSSION AND SUMMARY

As predicted, participants who wrote about the trauma topic rated their affective state as more unpleasant and more negative than participants writing about the control topic. Mood ratings from participants positive for a lifetime history of trauma were even more negative and unpleasant. This is consistent with data from a recent study showing participants with greater PTSD symptom severity showed greater negative affect and arousal when imagining their trauma than controls (McDonagh-Coyle et al, 2001). In the current study, participants in the trauma writing group also displayed a measurable increase in physiological arousal after writing which did not occur in the control group. These findings are consistent with recent data from other researchers indicating writing about trauma activates negative emotion and arousal (Norman et al., 2004; Sloan & Marx, 2004). This finding is an important piece to continued speculation on the mechanisms of the disclosure effect; further research conducted on affective and physiological changes immediately after disclosure may help uncover key components contributing to the effectiveness of the procedure.

Importantly, both subjective ratings and physiological measurements indicated that writing about trauma induces negative affect and arousal, which suggests written disclosure may be a vehicle for inducing naturally occurring affect in the laboratory. As previously mentioned, typical methods of affect induction are not personally relevant and therefore they do not mimic naturally occurring affect. This study suggests that written disclosure of trauma, which is personally relevant, can be used to induce a negative affective state in the laboratory.

Results from pain testing reflect a complex interaction between lifetime history of trauma, experience with pain testing, and writing topic. The most clear-cut findings emerged for radiant heat testing. As was predicted, for this test, among participants with no prior history of pain testing (no baseline group), writing about trauma induced heightened pain sensitivity (hyperalgesia). In contrast, among participants who had pain testing before, writing about trauma induced decreased pain sensitivity (analgesia), which implies a conditioned contextual fear may have been induced during of pain testing on day one. This is consistent with prior research showing that when an aversive stimulus is paired with a previously neutral cue, both animals and humans later experience a conditioned fear when only the cue is present, and this conditioned fear induces analgesia (Fanselow, 2000; Fendt & Fanselow, 1999). These processes may have been engaged during baseline testing, and serve as one explanation for the analgesia observed on day two. However, if conditioned contextual fear was induced, physiological and subjective data would be expected to reflect this fear via indications of heightened affect and arousal. This did not occur. Physiological and subjective data showed heightened levels of affect and arousal in the no baseline group compared to the baseline group, suggesting that prior exposure to testing reduced affective response after a second day of testing.

Results showed other differences in pain sensitivity when trauma history was included in analysis. In contrast to the differences observed in the no trauma history group, withdrawal latencies in the trauma history group were about the same for baseline and no baseline participants. These findings indicate there may be preexisting

differences in affective and physiological responsivity based on lifetime history of trauma. That is, prior history of testing may cause more interferences with mood induction in participants with no history of trauma, or alternatively, trauma history participants may be less susceptible to effects of repeat testing. One explanation for this finding might involve a central nervous system mechanism of pain modulation called diffuse noxious inhibitory controls (DNIC; Le Bars et al., 1981). DNIC is a mechanism in which one noxious stimulus inhibits pain caused by another stimulus. Recent evidence has indicated the DNIC process declines with age, and that this may be influenced by age-related variables such as lifetime experience of stress (Edwards, Fillingim & Ness, 2002; Edwards, Ness, Weigent & Fillingim, 2003). Participants in the current study who were positive for lifetime trauma history may have similar levels of lifetime stress observed in normal older adults, as such, DNIC could be impaired in traumatized individuals.

These findings are similar to research indicating elevated affective and physiological response in women with PTSD during a trauma imagery task, but reduced autonomic responding during an active, mental arithmetic task (McDonagh-Coyle et al, 2001). In fact, several researchers have found reduced responding in PTSD participants compared to normal controls during active, mental tasks (Blanchard et al., 1989; Keane et al., 1998). Further research has shown individuals who appraise a task as a threat show reduced autonomic reactivity in comparison to individuals who appraise a task as a challenge (Blascovitch, Kibler, Ernest, Tomaka & Vargas, 1994; Tomaka et al., 1999; Tomaka, Blascovitch, Kelsey, & Leitten, 1993; Tomaka, Blascovitch, Kibler, & Ernst,

1997). In this study, its possible that trauma history participants were more likely to perceive pain testing as a threat, which might cause reduced autonomic responsivity. This might explain why there was no difference in pain threshold between the baseline and no baseline sections of the trauma history group.

In contrast to the radiant heat findings discussed above, participants who wrote about the neutral topic had the highest levels of affect and arousal during constant heat testing. This could indicate that the constant procedure itself produces affect and that any affect induced by the writing procedure was short-lived. Furthermore, the constant procedure may induce affect differently depending on prior emotional state; thus the trauma writing group, presumably already in a negative mood may not respond as much as the neutral writing group because they are presumably in a neutral state.

Alternatively, the increased affective and physiological responding observed by participants who wrote about the neutral topic may be reflective of recent research on the role of attention in pain perception. Researchers have argued that attention to pain can enhance its perception (Villemure & Bushnell, 2002), and that alterations in attention can be influenced by emotional state (Ohman, et al., 2001; Villemure, Slotnick & Bushnell, 2003). Its possible that participants who wrote about the neutral topic were more focused on their pain during constant stimulus testing, therefore these participants displayed higher levels of affect and arousal in response to their pain. In contrast, the negative emotions induced in participants who wrote about the trauma topic may have diverted these participants' attention to the contents of their writing, which may have attenuated their pain perception.

Findings from tourniquet testing encompass many of the previously mentioned phenomena. Participants who wrote about the trauma topic had the highest arousal and negative mood ratings, however, the writing topic itself did not seem to influence pain tolerance. Instead, lifetime history of trauma was a significant variable in the neutral writing/no baseline group, who can be seen as a control group. When compared to all other groups, this group had the highest pain tolerance (no trauma group) and lowest pain tolerance (trauma group), which suggests there may be preexisting differences in physiological reactivity between trauma and no trauma history participants that aren't apparent during thermal testing. Tourniquet data should be interpreted cautiously, however, due to the common, but high level of variability in pain tolerance.

Findings from the tourniquet procedure are consistent with a great deal of research now suggesting that individuals with PTSD have heightened sympathetic nervous system activity (Yehuda, 2004), which implies facilitation of the pain response. This relates back to the potential effects of lifetime stress on DNIC. If DNIC is impaired, pain response will also be facilitated. Therefore, enhanced sympathetic activity or impaired DNIC processes may be a potential explanation why the trauma history participants had the shortest pain tolerance on the tourniquet procedure. Further still, perhaps this distinction was most apparent during tourniquet testing because testing took up to 25 minutes, whereas each of the radiant heat tests were only a few seconds long.

As previously discussed, research has indicated that emotion plays a significant role in pain modulation, however, another line of research suggests that pain

patients are more likely to inhibit their emotions (Traue, 1995). Such inhibition of affect and corresponding increases in muscle tension could cause increased pain. Two recent studies which involved having participants suppress pain related thoughts while submerging their arm in a cold-pressor device found that participants instructed to inhibit reported more pain (Cioffi & Hollaway, 1993; Sullivan, Rouse, Bishop & Johnston, 1997). Other researchers have indicated that a high percentage of chronic pain patients suffer from alexithymia, a condition in which a person is emotionally unexpressive (Lumley, Asselin, & Norman, 1997). Still others have suggested that another risk factor for chronic pain is the experience of trauma or abuse (Haber & Roos, 1985; Burns, 2000). Burns has even argued for a subset of chronic pain patients for whom repression of negative emotions has led to physical pain in the classic psychodynamic conversion sense (Burns, 2000). Taken together, these studies suggest that both emotional inhibition and trauma may be risk factors for the development of chronic pain. From this perspective, interventions that facilitate emotional and cognitive processing of trauma, such as the written emotional disclosure paradigm, may be clinically useful in chronic pain populations.

Norman and colleagues (2004) recently studied the effects of the disclosure paradigm with chronic pelvic pain, but found only minimal reductions in pain. Unfortunately, the study was limited because the researchers instructed participants to specifically write about their pain; Pennebaker has argued the paradigm works best if participants are allowed to choose their writing topic. In addition, the researchers failed to collect data on trauma history, and may have included participants who were

depressed and taking psychotropic medications. Given how little is know about the mechanisms of the effect, and the specificity of the typical methodology used in writing studies, the Norman study stepped away from typical methodology a bit prematurely. However, it is also possible that the writing paradigm cannot be applied to more specific types of health problems like chronic pain.

In contrast to the Norman study, researchers have demonstrated that written emotional disclosure can decrease certain types of pain. Smyth, Stone, Hurewitz & Kaell (1999) recently conducted an emotional disclosure study with rheumatoid arthritis sufferers in which physician measurements of disease activity, symptomatology, pain, and swelling were examined. A significant improvement in overall disease activity after writing was found for the rheumatoid arthritis patients.

Kelley, Lumley & Leisen (1997) conducted a similar study with rheumatoid arthritis patients, but patients were asked to make verbal disclosures via a tape recorder rather than write. Pain, physical dysfunction, affective disturbance and joint conditions were assessed before intervention and every two weeks for three months. Results indicated significant improvements in affective disturbance and physical functioning, but improvements did not occur until after the first two weeks following the writing phase. In fact, during these first two weeks, the experimental group actually functioned more poorly than the control group, which suggests the process of changing negative emotional memories and the subsequent changes in health may take time (Kelley, Lumley & Leisen, 1997). The authors suggest the success of the intervention with a chronic pain population may bode well for its subsequent success with other types of

chronic pain and its inclusion in chronic pain treatment programs.

Sullivan & Neish (1999) observed the effect of emotional disclosure on pain during a dental procedure. The researchers classified participants as catastrophizers and non-catastrophizers based on scores on the Pain Catastrophizing Scale. Participants in the disclosure condition wrote on their fears and thoughts about dental treatment just prior to the procedure, while participants in the control condition wrote about their activities the previous day. Results indicated that in the control condition, catastrophizers reported significantly more pain than non-catastrophizers. In the experimental condition, there was no significant difference in pain ratings between catastrophizers and non-catastrophizers. Furthermore, participants in the disclosure condition reported significantly less pain than those in the control condition. This study suggests emotional disclosure is effective in reducing the effects of catastrophizing on pain and may be effective in increasing pain tolerance.

In addition to the current study, the studies described above provide preliminary evidence that written disclosure can alter pain sensitivity. As Pennebaker has recently suggested, perhaps one of the most important aspects of any intervention-type research is its outcome, but more specifically in this era of managed care, it is whether the outcome is cost-effective, and whether we can determine when and with whom the intervention will work (2004). Pennebaker argues that the disclosure paradigm may serve a large number of people needing quick (and cost-effective) treatments. Given the high annual cost of chronic pain and pain related disability, the intervention would be particularly suited to this area.

One limitation of this study was that participants were instructed that once the writing period was over, they were to remove their writing, fold it up, and return it to the envelope that contained their instructions; they were then instructed to place the envelope in a file drawer outside the experiment room. This was done to protect confidentiality and to eliminate expectancy effects by keeping the experimenters blind. However, by allowing participants to effectively remove their writing from the experiment room, they may have also been able to remove it from their immediate consciousness. In this case, the effects of writing about trauma may have been short-lived. We are currently attempting to address this issue in a new study in which participants remain seated with their writing contents in full view throughout pain testing.

A second limitation of the study has to do with participant selection. In attempts to stay as close to Pennebaker's methodology as possible, we used his Childhood Trauma Questionnaire during prescreening to help establish a control group with virtually no trauma history, and a trauma group with the highest scores. This measure may be flawed because it asks participants to rate whether certain experiences occurred, and whether they were traumatic, however, "traumatic" is never defined. A better measure that maps more closely to the DSM-IV concept of traumatic, which defines a traumatic event as one in which the victim experienced intense helplessness, hopelessness, horror, or fear for their life might yield a more homogenous and sound sample of trauma participants.

Future research should seek to determine the length of time between affect induction and affect extinction after writing about trauma. In addition, researchers should continue to investigate these short-term effects of the disclosure paradigm. Future research applying written disclosure to laboratory induced pain should also take into account the effects of prior history of pain testing, either by removing baseline testing from experimentation, by conducting experiments with a greater length of time between baseline testing, writing and post-testing, or by using extinction sessions to eliminate conditioned fear. Future studies should also incorporate a better measure of lifetime experience of trauma.

In conclusion, the written emotional disclosure paradigm induces physiological arousal and subjective reports of negative affect, implying that it may be a useful method for affect induction in the laboratory. Furthermore, writing about trauma interacts with trauma history, and prior history of pain testing to increase pain sensitivity after thermal testing, but not during a constant stimulation subjective pain rating task. However, writing about trauma does enhance participant ratings of arousal and unpleasantness after a pain tolerance test.

REFERENCES

Affleck, G., Tennen, H., Urrows, S., & Higgens, P. (1991). Individual differences in the day-to-day experience of chronic pain: A prospective daily study of rheumatoid arthritis patients. *Health Psychology, 10,* 419-426.

Blanchard, E.B., Kolb, L.C., Gerardi, R.J., Ryan, P., & Pallmeyer, T.P. (1986). Cardiac response to relevant stimuli as a tool for diagnosing post-traumatic stress disorder in Vietnam veterans. *Behavior Therapy, 17,* 592-606.

Blanchard, E.B. (1990). Elevated basal levels of cardiovascular responses in Vietnam veterans with PTSD: A health problem in the making? *Journal of Anxiety Disorders, 4,* 233-237.

Blascovich, J., Kibler, J., Ernst, J.M., Tomaka, J., & Vargas, Y. (1994). Manipulations of cardiac and vascular reactivity: Effects on cognitive appraisal. *Psychophysiology, 31,* S26.

Burns, J.W. (2000). Repression in chronic pain: An idea worth recovering. *Applied and Preventive Psychology, 9,* 173-190.

Cioffi, D., & Hollaway, J. (1993). Delayed costs of suppressed pain. *Journal of Personality and Social Psychology, 64,* 274-282.

de Wied, M., & Verbaten, M.N . (2001). Affective pictures processing, attention, and pain tolerance. *Pain, 90,* 163-172.

Edwards, R.R., Fillingim, R.B., & Ness, T.J. (2003). Age-related differences in endogenous pain modulation: A comparison of diffuse noxious inhibitory controls in healthy older and younger adults. *Pain, 101,* 155-165.

Edwards, R.R., Ness, T.J., Weigent, D.A. & Fillingim, R.B. (2003*)*. Individual differences in diffuse noxious inhibitory controls (DNIC). *Pain, 106,* 427-437.

Fanselow, M.S. (2000*)*. Contextual fear, gestalt memories, and the hippocampus. *Behavioral Brain Research, 110,* 73-81.

Fanselow, M.S. and Baackes, M.P. (1982*)*. Conditioned fear-induced opiate analgesia on the formalin test: Evidence for two aversive motivational systems. *Learning and Motivation, 13,* 200-221.

Fendt, M. and Fanselow, M.S. (1999*)*. The neuroanatomical and neurochemical basis of conditioned fear. *Neuroscience and Biobehavioral Reviews, 23,* 743-760.

Fernandez, E. and Turk, D.C. (1992). Sensory and affective components of pain: separation and synthesis. *Psychological Bulletin. 112(2),* 205-217.

Fields, H.L. (2000*)*. Pain modulation: Expectation, opioid analgesia, and virtual pain. *Brain Research, 122,* 245-253.

Fields, H.L., & Basbaum, A.I. (1999). Central nervous systems of pain modulation. In P.D. Wall & R. Melzack (Eds.), *Textbook of Pain* (pp. 309-329). Edinburgh: Churchill Livingston.

Fillingim, R.B., Maixner, W., Girdler, S.S., Light, K.C., Harris, M.B. et al. (1997*)*. Ischemic but not thermal pain sensitivity varies across the menstrual cycle. *Psychosomatic Medicine, 59,* 512-520.

Foa, E.B., Zinberg, R., & Rothbaum, B.O. (1992*)*. Uncontrollability and unpredictability in post-traumatic stress disorder: An animal model. *Psychological Bulletin, 112,* 218-238.

Haber, J.D., & Roos, C. (1985). Effects of spouse abuse and/or sexual abuse in the development and maintenance of chronic pain in women. *Advances in Pain Research and Therapy, 9,* 889-895.

Janssen SA, Arntz A. (1996) Anxiety and pain: Attentional and endorphinergic influences. *Pain, 66*, 145-150.

Janssen SA, Arntz A. (1999) No interactive effects of naltrexone and benzodiazepines on pain during phobic fear. *Behavioral Research and Therapy , 37,* 77-86.

Keane, T.M., Kolb, L.C., Kaloupek, D.G., Orr, S.P., Blanchard, E.B., Thomas, R.G., Hseih, F.Y., & Lavori, P.W. (1998). Results of a multisite clinical trial on the psychophysiological assessment of posttraumatic stress disorder. *Journal of Consulting and Clinical Psychology, 66,* 914-923.

Keefe, F.J., Lumley, M., Anderson, T., Lynch, T., & Carson, K.L. (2001). Pain and emotion: New research directions. *Journal of Clinical Psychology, 57(4),* 587-607.

Kelley, J.E., Lumley, M.A. & Leisen, J.C (1997). Health effects of emotional disclosure in rheumatoid arthritis patients. *Health Psychology, 16(4),* 331-340.

Kloss, J.D. and Lisman, S.A. (2002). An exposure-based examination of the effects of written emotional disclosure. *British Journal of Health Psychology, 7,* 31-46.

Lang, P.J. (1980). Behavioral treatment and bio-behavioral assessment. In J.B. Sidowski, J.H. Johnson and T.A. Williams, (Eds.), *Technology in mental health care delivery systems* (pp. 119-137). Norwood, NJ: Ablex.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (1995). International affective picture system (IAPS): technical manual and affective ratings, Gainesville, FL: Center for Research in Psychophysiology.

Le Bars, D., Chitour, D., & Clot, A.M. (1981). The encoding of thermal stimuli by diffuse noxious inhibitory controls (DNIC). *Brain Research, 230,* 394-399.

Lepore, S.J. & Smyth, J.M. (Eds.). (2002). *The writing cure. How expressive writing promotes health and emotional well-being.* Washington, DC: American Psychological Association.

Littrell, J. (1998). Is the reexperience of painful emotion therapeutic? *Clinical Psychology Review, 18(1),* 71-102.

Lumley, M.A., Asselin, L.A., & Norman, S. (1997). Alexithymia in chronic pain patients. *Comprehensive Psychiatry, 38(3),* 160-165.

Meagher, M.W., Arnau, R.C., & Rhudy, J.L. (2001). Pain and emotion: Effects of affective picture modulation. *Psychosomatic Medicine, 63,* 79-90.

Melzack, R., & Katz, J. (1990). Pain 'memories' in phantom limbs: review and clinical observations. *Pain, 43,* 319-336.

Melzack, R., & Wall, P.D. (1965). Pain mechanisms: A new theory. *Science, 150,* 5971-979.

Mc-Donagh-Coyle, A.M., McHugo, G.J., Friedman, M.J., Schnurr, P.P., Zayfert, C., and Descamps, M. (2001). Psychophysiological reactivity in female sexual abuse survivors. *Journal of Traumatic Stress, 14 (4),* 667-683.

Norman, S.A., Lumley, M.A., Dooley, J.A., & Diamond, M.P. (2004). For whom does it work? Moderators of the effect of written emotional disclosure in a randomized trial among women with chronic pelvic pain. *Psychosomatic Medicine, 66,* 174-183.

Ohman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology, 130,* 466-478.

Pennebaker, J.W. (2004*)*. Theories, therapies, and taxpayers: On the complexities of the expressive writing paradigm. *Clinical Psychology: Science and Practice, 11(2),* 138-142.

Pennebaker, J.W. (2000). Psychological factors influencing the reporting of physical symptoms. In A.A. Stone, J.S. Turkkan, C.S. Bachrach, J.B. Jobe, H.S. Kurtzman & V.S. Cain (Eds.), *The Science of Self-report Implications for Research and Practice* (pp. 299-315). Mahwah, NJ: Erlbaum.

Pennebaker, J.W. (1982). *The psychology of physical symptoms*. New York, NY: Springer-Verlag.

Pennebaker, J.W., & Beall, S.K. (1986*)*. Confronting a traumatic event: Toward an understanding of inhibition and disease. *Journal of Abnormal Psychology, 95(3),* 274-281.

Pennebaker, J.W., & Susman, J.R. (1988*)*. Disclosure of psychosomatic processes. *Social Science and Medicine, 26(3),* 327-332.

Pitman, R.K., Van Der Kolk, B.A., Orr, S.P., & Greenberg, M.S. (1990). Naloxone-reversible analgesic response to combat related stimuli in post-traumatic stress disorder. *Archives of Gen Psychiatry, 47,* 541-544.

Radloff, L. S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385-401.

Rhudy, J.L., & Meagher, M.W. (2000*)*. Fear and anxiety: divergent effects on human pain thresholds. *Pain, 84,* 65-75.

Rhudy, J.L., & Meagher, M.W. (2001). Noise stress and human pain thresholds: Divergent effects in men and women. *The Journal of Pain, 2(1),* 57-64.

Rhudy, J.L., & Meagher, M.W. (2001*)*. The role of emotion in pain modulation. *Current Opinion in Psychiatry, 14,* 241-245.

Rhudy, J.L., & Meagher, M.W. (2003). Negative affect: Effects on an evaluative measure of human pain. *Pain, 104,* 617-626.

Sloan, D.M., & Marx, B.P. (2004*)*. A closer examination of the structured written disclosure procedure. *Journal of Consulting and Clinical Psychology, 72(2),* 165-175.

Sloan, D.M., & Marx, B.P. (2004*)*. Taking pen to hand: Evaluating theories underlying the written disclosure paradigm. *Clinical Psychology: Science and Practice, 11(2),* 121-137.

Smyth, J.M., Stone, A.A., Hurewitz, A., & Kaell, A. (1999*)*. Effects of writing about stressful experiences on symptom reduction in patients with asthma or

rheumatoid arthritis. *Journal of the American Medical Association, 281(14),* 1304-1309.

Smyth, J.M. (1998*)*. Written emotional expression: Effect sizes, outcome types, and moderating variables. *Journal of Consulting and Clinical Psychology, 66(1),* 174-184.

Snyder, D.K., Gordon, K.C., & Baucom, D.H.. (2004*)*. Treating affair couples: Extending the written disclosure paradigm to relationship trauma. *Clinical Psychology: Science and Practice, 11(2),* 155-159.

Sullivan, M.J.L., & Neish, N. (1999*)*. The effects of disclosure on pain during dental hygiene treatment: The moderating role of catastrophizing. *Pain, 79,* 155-163.

Sullivan, M.J.L., Rouse, D., Bishop, S., & Johnston, S. (1997*)*. Thought suppression, catastrophizing, and pain. *Cognitive Therapy and Research, 21,* 555-568.

Tomaka, J., Blascovich, J., Kelsey, R.M., & Leitten, C.L. (1993*)*. Subjective, physiological and behavioral effects of threat and challenge appraisal. *Journal of Personality and Social Psychology, 65,* 248-260.

Tomaka, J., Blascovich, J., Kibler, J., & Ernst, J.M. (1997*)*. Cognitive and psychosocial antecedents of threat and challenge appraisal. *Journal of Personality and Social Psychology, 73,* 63-72.

Tomaka, J., Palacios, R., Schneider, K.T., Colotla, M., Concha, J.B., & Herrald, M.M. (1999*)*. Assertiveness predicts threat and challenge reactions to potential stress among women. *Journal of Personality and Social Psychology, 76,* 1008-1021.

Traue, H.C. (1995) Inhibition and muscle tension in myogenic pain. In J.W. Pennebaker (Ed.), *Emotion, Disclosure, and Health* (pp. 155-176). Washington, DC: American Psychological Association.

Turk, D.C. (1996). Biopsychosocial perspective on chronic pain. In R.J. Gatchel & D.C. Turk (Eds.), *Psychological approaches to pain management* (pp. 3-32). New York, NY: Guilford.

Turk, D.C., Meichenbaum, D., & Genest, M. (1983). *Pain and Behavioral Medicine, a Cognitive-Behavioral Perspective*. New York, NY: Guilford.

Velten, E. (1968). A laboratory task for induction of mood states. *Behavioral Research and Therapy, 6,* 473-482.

Villemure, C., & Bushnell, M.C. (2002). Cognitive modulation of pain: How do attention and emotion influence pain processing? *Pain, 95,* 195-199.

Villemure, C., Slotnick, B.M., & Bushnell, M.C. (2003). Effects of odors on pain perception: Deciphering the roles of emotion and attention. *Pain, 106,* 101-108.

Watson, D., Clark, L.A., & Tellegen. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063-1070.

Weisenberg, M., Raz, T., & Hener, T. (1998). The influence of film-induced mood on laboratory pain. *Pain, 76,* 365-375.

Yehuda, R. (2004). Post-traumatic stress disorder. *The New England Journal of Medicine, 346 (2),* 108-114.

Zautra, A.J., & Smith, B.W . (2001*)*. Depression and reactivity to stress in older women with rheumatoid arthritis and osteoarthritis. *Psychosomatic Medicine, 63,* 687-696.

Zelman, D.C., Howland, E.W., Nichols, S.N., & Cleeland, C.S. (1991*)*. The effects of induced mood on laboratory pain. *Pain, 46,* 105-111.

APPENDIX

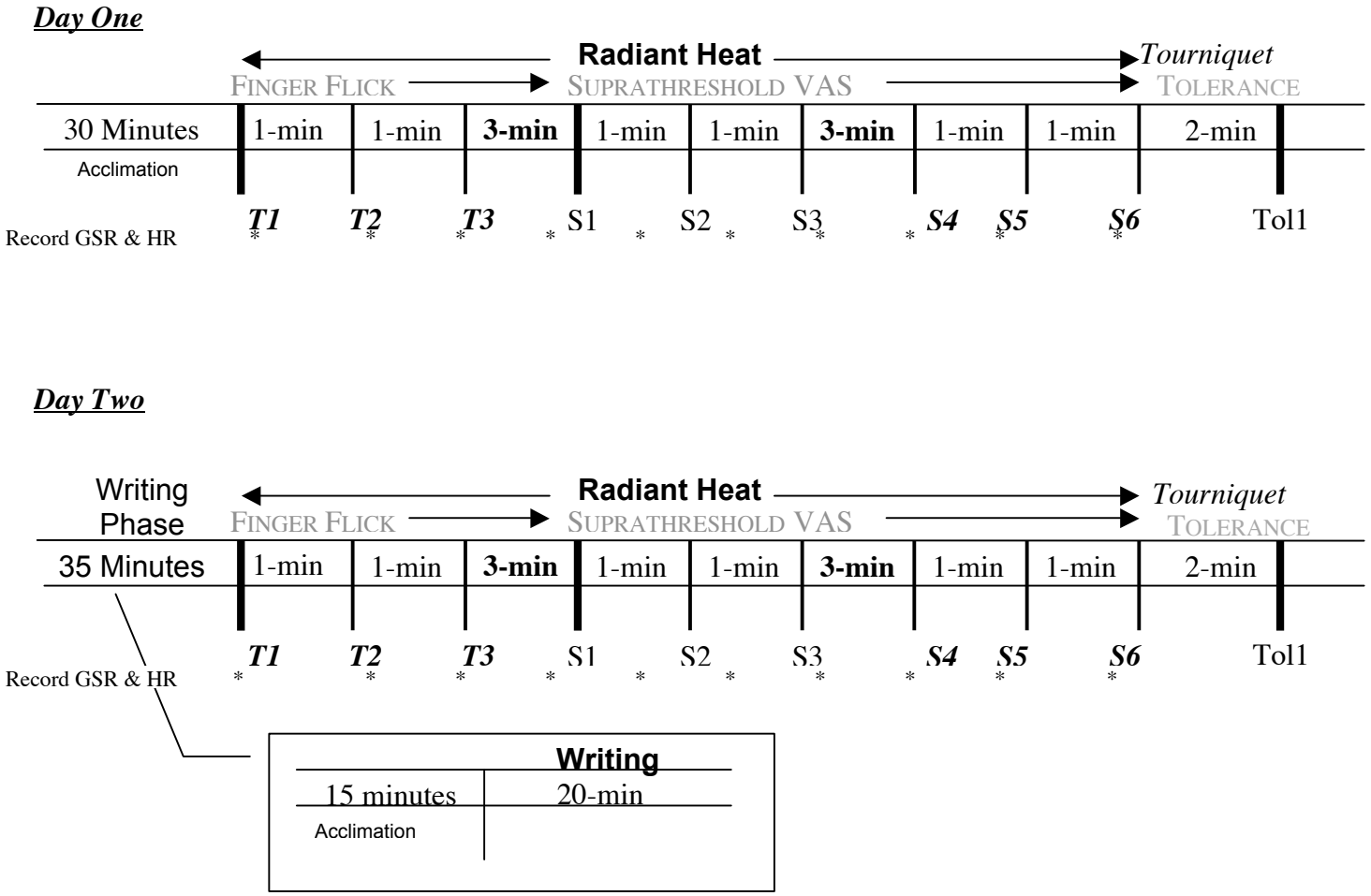


Fig. 1. Experiment timeline for day one and day two.

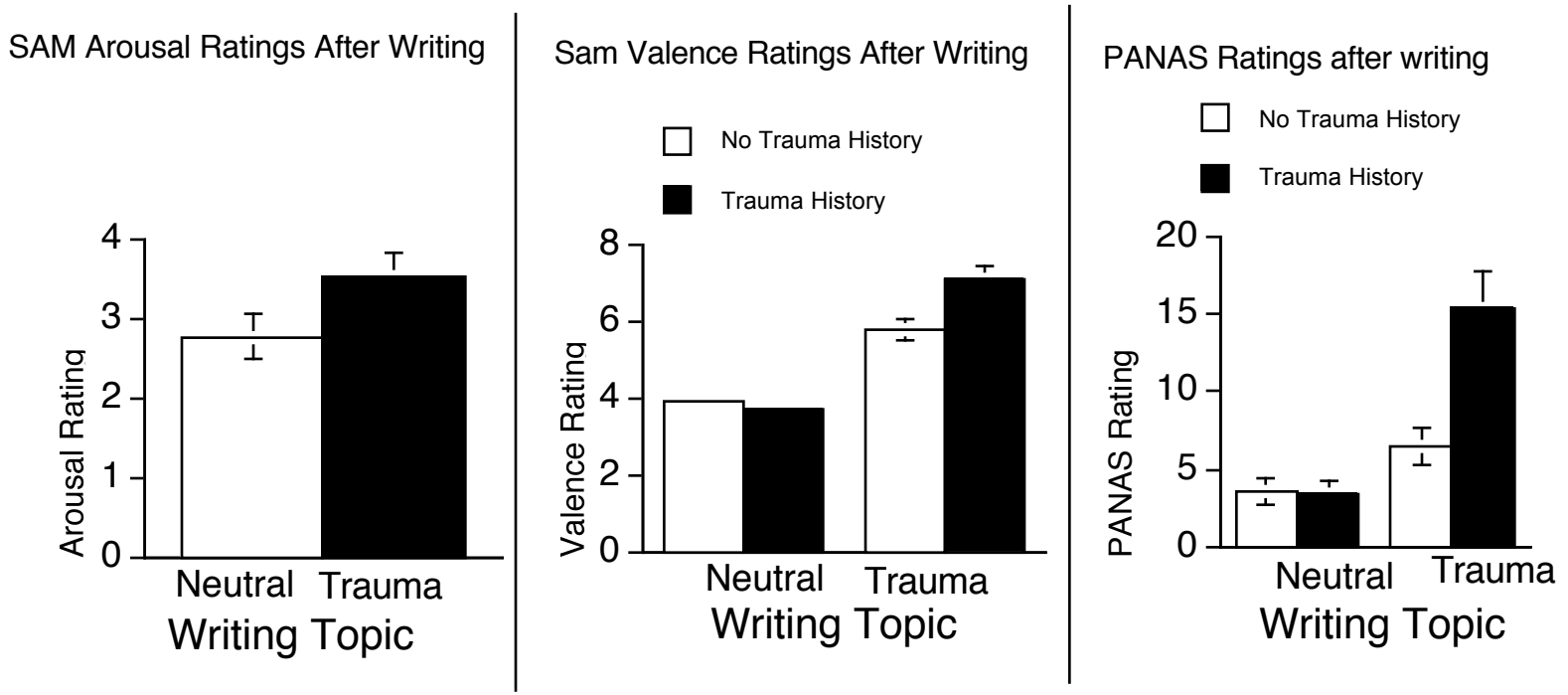


Fig. 2. Subjective affect ratings after writing procedure. The left panel depicts the effects of writing topic on Self Assessment Manikin (SAM) arousal ratings. This panel shows that writing about the trauma topic increases participant ratings of arousal. The middle and right panels depict the effects of trauma history and writing topic on SAM valence ratings (middle) and Positive Affect Negative Affect Scale (PANAS) ratings (right). The middle and right panels show that writing about the trauma topic significantly increases participant ratings of negative affect, particularly if the participant has a lifetime history of trauma. Data are expressed as the mean $\pm$ SEM.

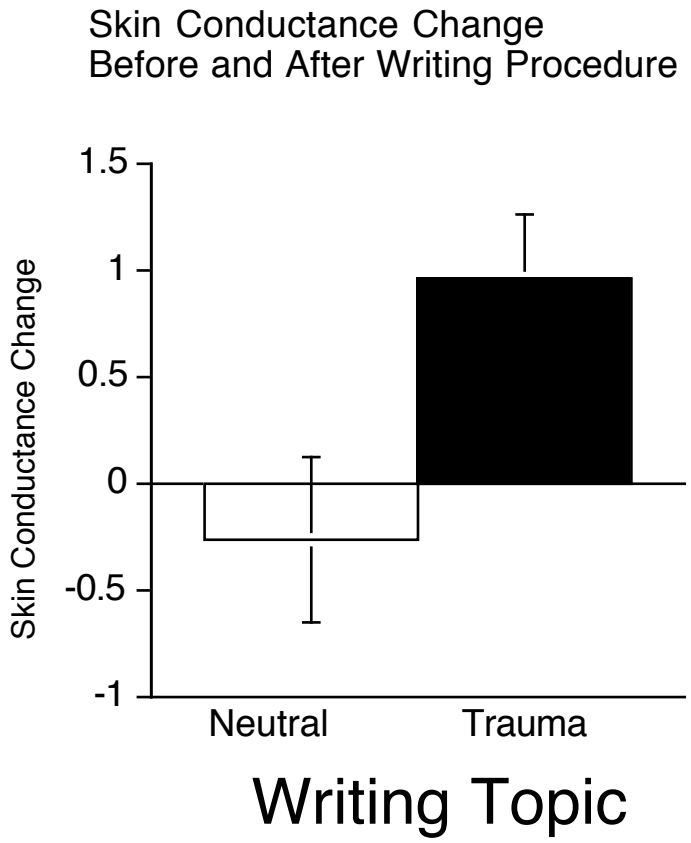
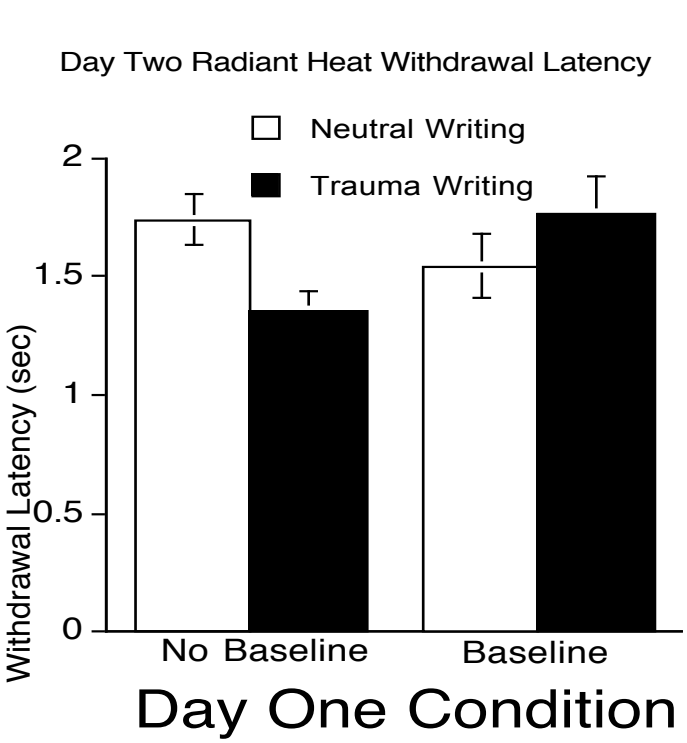


Fig. 3. Change in skin conductance after writing. This figure depicts the effect of writing topic on skin conductance, which is a physiological indicator of affect and arousal. Participants who wrote about the trauma topic showed a significant increase in skin conductance after writing. Data are expressed as the mean ± SEM.



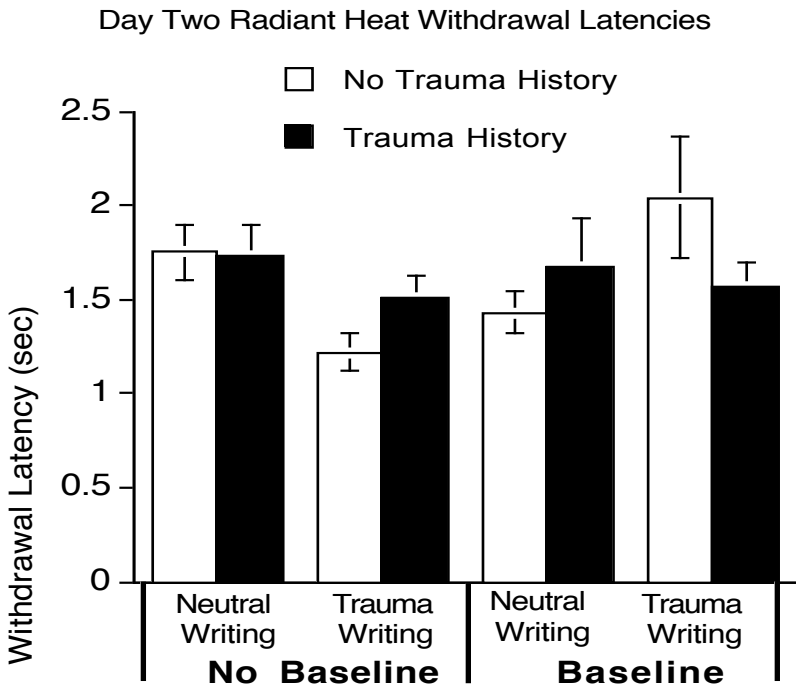


Fig. 4. (left) The effect of writing topic and day one condition on pain thresholds to radiant heat. Participants in the no baseline group, (no prior pain testing experience) who wrote about trauma displayed a hyperalgesic response (increased pain sensitivity). In the baseline testing group; participants who wrote about trauma displayed an analgesic response, taking the longest to reach pain threshold. Data are expressed as the means $\pm$ SEM.

Fig. 5. (right) The effect of writing topic, baseline pain testing, and lifetime trauma history on pain thresholds to radiant heat. Participants who had no lifetime history of trauma and wrote about trauma and had baseline testing had the longest latencies to withdrawal. The no baseline testing counterpart of this group had the shortest latencies. Data are expressed as the mean $\pm$ SEM.

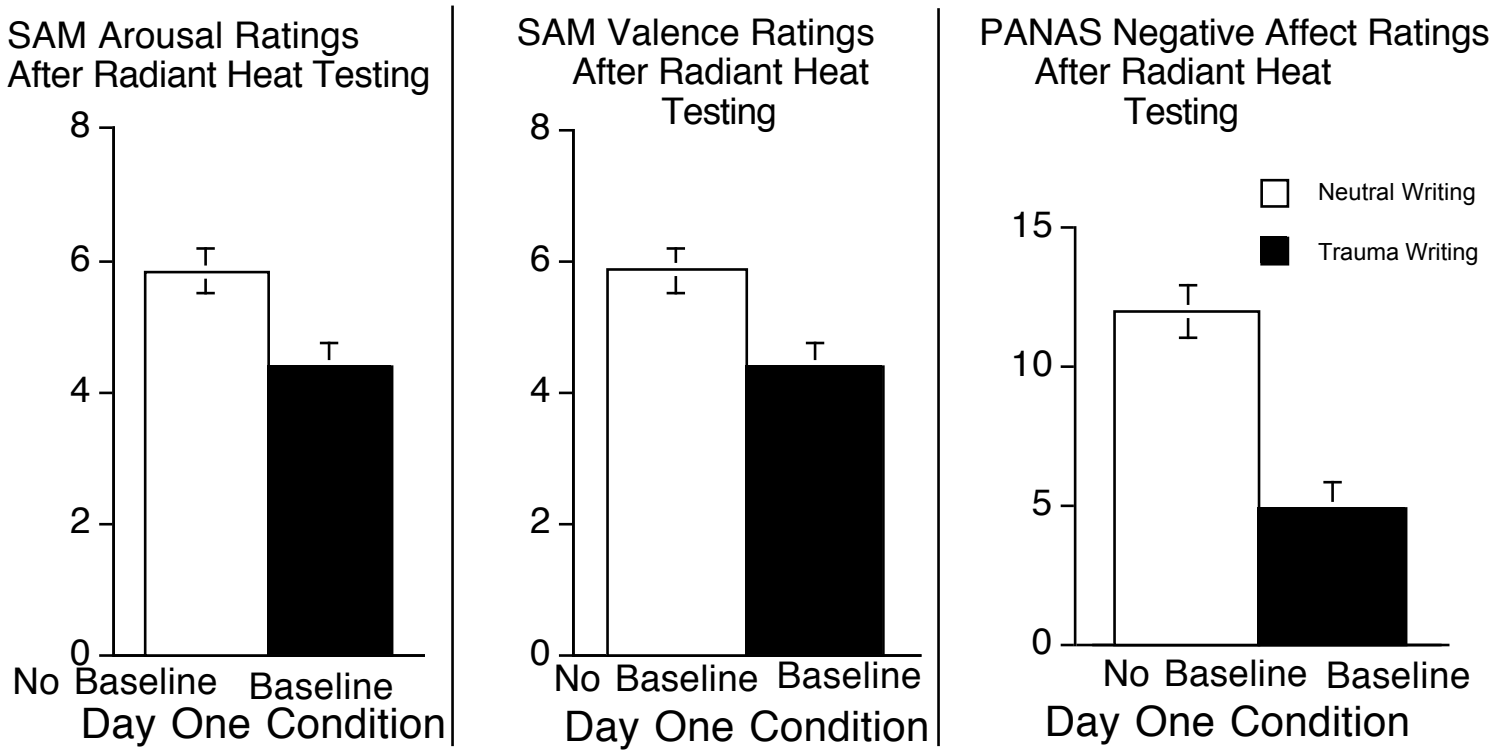


Fig. 6. Subjective affect ratings after finger flick testing. The left panel depicts the effects of baseline pain testing on Self Assessment Manikin (SAM) arousal ratings. This panel shows that baseline pain testing on day one decreases participant ratings of arousal after finger flick testing on day two. The middle and right panels depict the effects of baseline testing on participant ratings of negative affect. Both show that participants with no prior experience with pain testing (no baseline group), rate their affective state after finger flick testing as more unpleasant on the SAM and more negative on the PANAS than the baseline testing group. Data are expressed as the mean $\pm$ SEM.

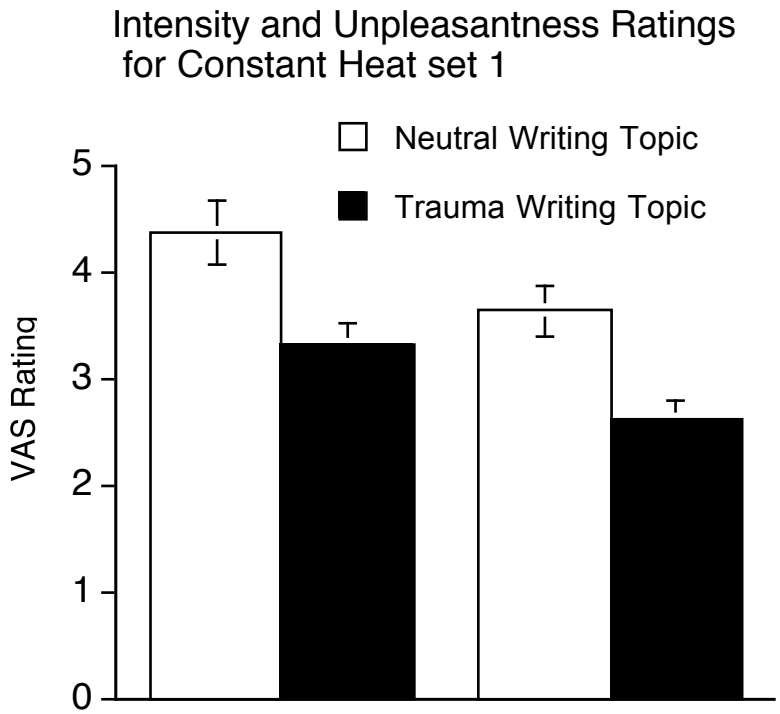


Fig. 7. Visual analogue scale ratings of intensity and unpleasantness for the first set of constant heat tests. This figure shows that participants who wrote about the trauma topic rated the constant stimulus tests as less intense and less unpleasant than the neutral writing group. Data are expressed as the mean ± SEM.

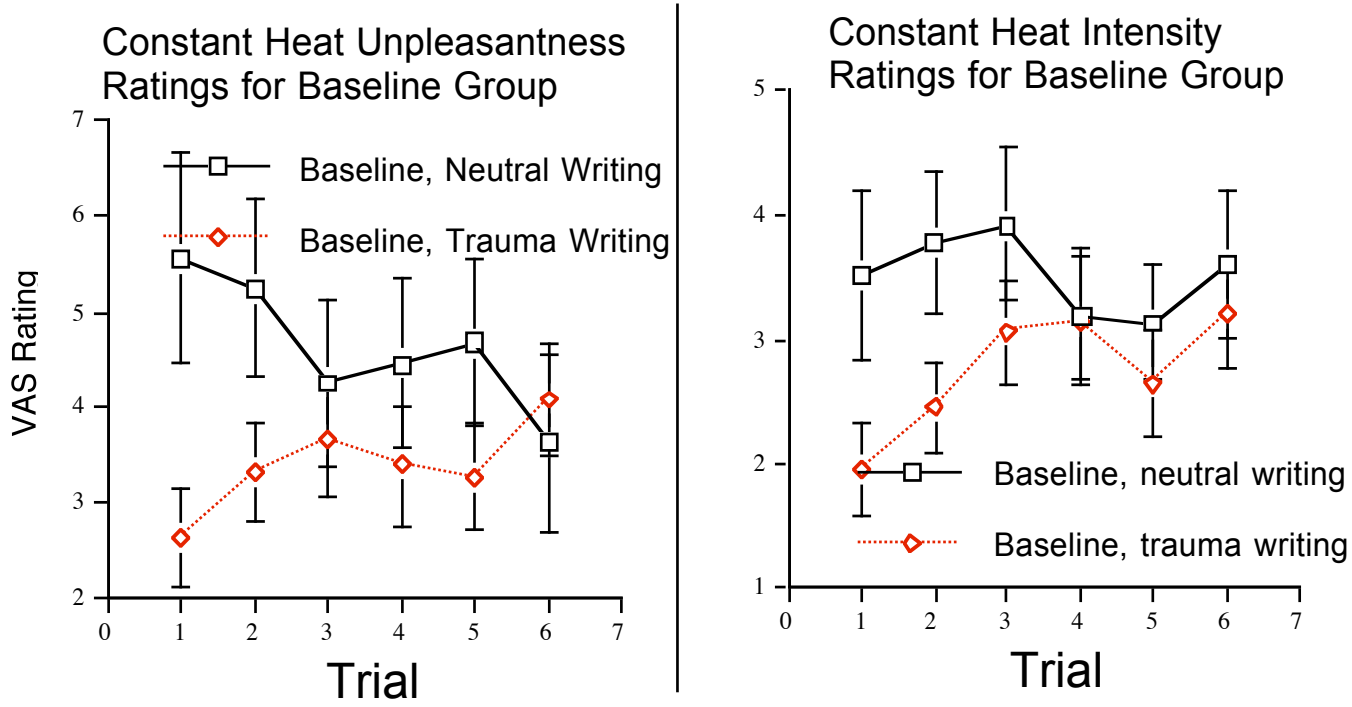


Fig. 8. Visual analogue scale ratings of intensity (right panel) and unpleasantness (left panel) across all six constant heat trials for baseline testing group. Both panels show within the baseline testing group, participants who wrote about trauma rated each test as less intense and less unpleasant than the neutral writing group. Data are expressed as the mean $\pm$ SEM.

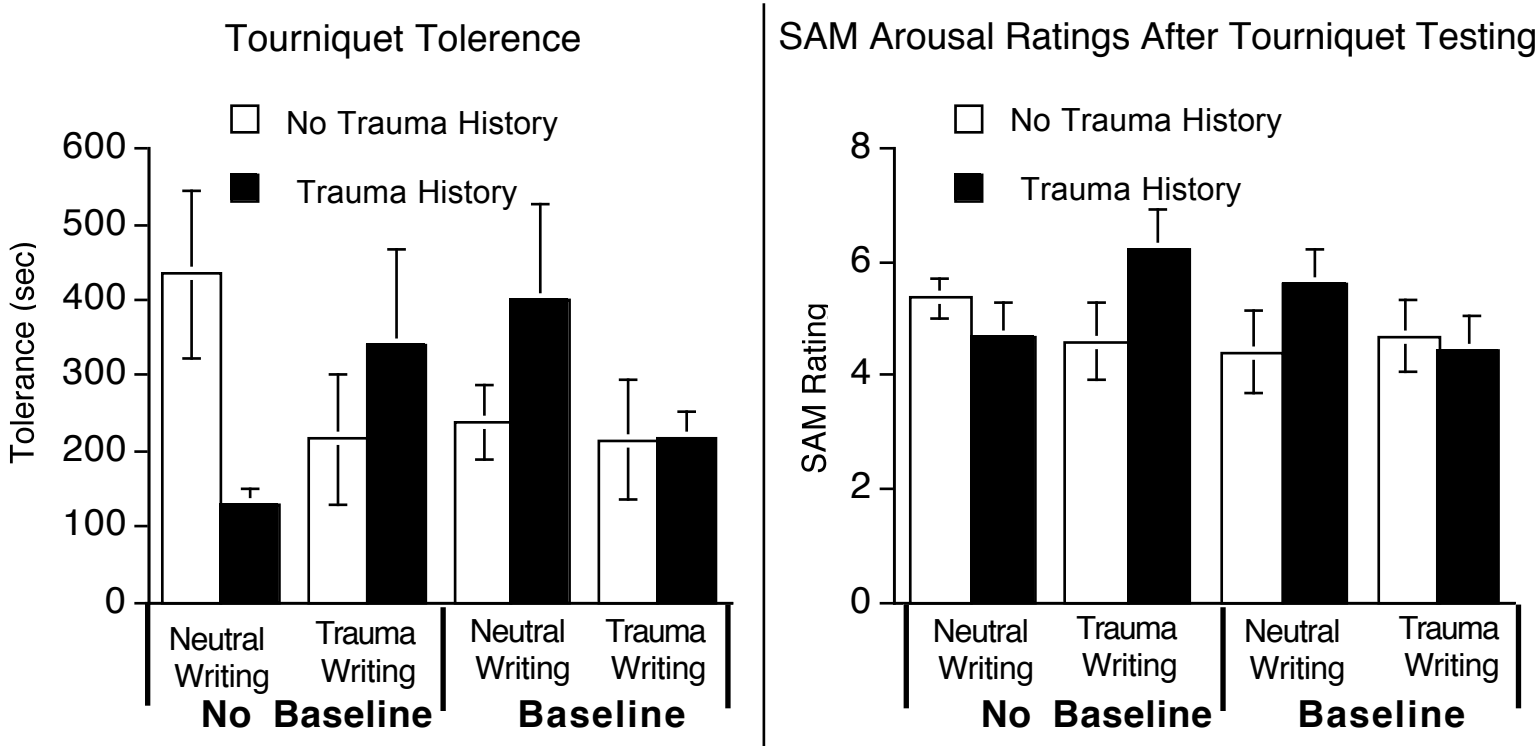


Fig. 9. (left) Tourniquet tolerance in seconds. This figure depicts an interaction effect between lifetime trauma history, writing topic and baseline testing on tourniquet tolerance in seconds. Participants in the no baseline/neutral writing condition with no prior history of trauma displayed the longest pain tolerance, while the trauma history section of this group displayed the shortest pain tolerance. This finding suggests that among participants undergoing the tourniquet test for the first time and writing about a neutral topic, pre-existing differences may exist between those with and without a lifetime history of trauma. Data are expressed as the mean $\pm$ SEM.

Fig. 10. (right) Self Assessment Manikin ratings of arousal after tourniquet testing. Participants in the trauma history/trauma writing group who did not complete baseline testing rated the tourniquet procedure as significantly more arousing than participants that did complete baseline testing. Data are expressed as the means $\pm$ SEM.

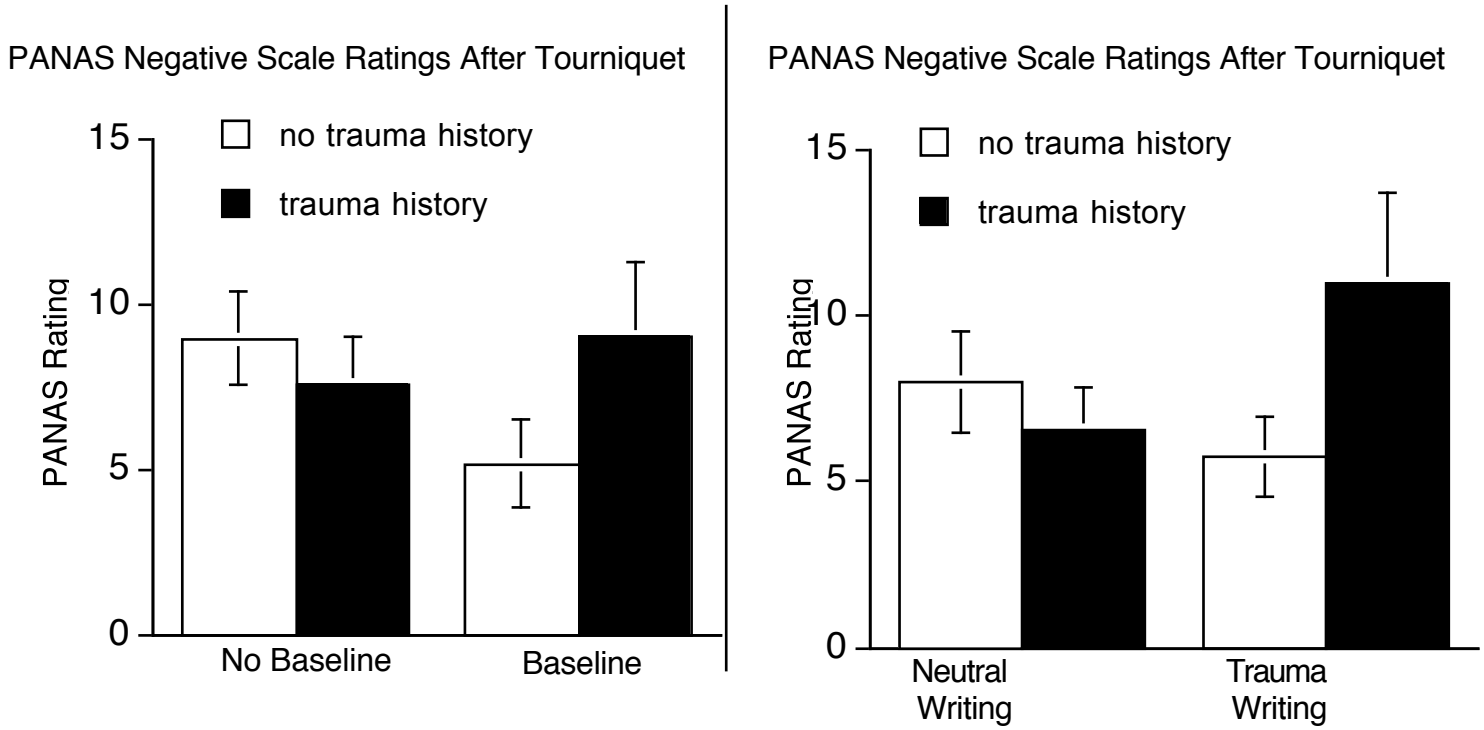


Fig. 11. PANAS ratings of negative affect after tourniquet testing. The left panel shows a significant interaction effect between day one condition and lifetime history of trauma on the negative affect scale of the PANAS. Participants in the baseline testing group with no trauma history rated their emotional state after the tourniquet test as significantly less negative than those in the baseline testing group with a history of trauma. Data are expressed as the mean $\pm$ SEM.
A second interaction effect between writing topic and trauma level on the negative affect scale of the PANAS is depicted on the right. Among participants with a lifetime history of trauma, those who wrote about the neutral topic rated their mood as less negative after the tourniquet test than those who wrote about traumatic experiences. Additionally, among those who wrote about traumatic experiences, those without a lifetime history of trauma rated their mood as less negative after the tourniquet test than those with a lifetime history of trauma. Data are expressed as the mean $\pm$ SEM.

VITA

Suzannah K. Creech

Permanent address: PO BOX 287, Helotes, TX 78023

Education:

M.S. in Psychology
Texas A&M University, August, 2004

B.A. with special honors in Psychology
The University of Texas at Austin,
May 2001

Presentations and Publications:

Huff, N.C., Creech, S., Valles, R., & Salinas, J.A. Lead effects on learned tasks in Wistar Kyoto and spontaneously hypertensive rats. Poster Presentation: Society For Neuroscience, San Diego, October 2001.

Grimes, J.S., Creech, S.K., & Meagher, M.W. Presentation of a distracter speeds the decay of shock induced hypoalgesia in humans. Poster presentation: World Congress on Pain, August 2002.

Grimes, J., Creech, S., Chokshi, N., Angermiller, S., Villa, E., Yates, J., Meagher, M. Noise Induced Stress Impacts Secondary Hyperalgesia in a Human Capsaicin Pain Model. Poster Presentation: American Pain Society Annual Meeting 2003.

Salinas, J., Creech, S., Valles, R., Huff, N. Pavlovian Fear in an Animal Model of ADHD. (manuscript in review)

Karlin, B., Creech, S. Grimes, J., Clark, T., Meagher, M., Morey, L. Use of the Personality Assessment Inventory with Individuals with chronic Pain: an empirical investigation. Poster Presentation: American Psychological Association annual meeting, 2003.

Karlin, B., Creech, S. Grimes, J., Clark, T., Meagher, M., Morey, L. Use of the Personality Assessment Inventory with Individuals with chronic Pain: an empirical investigation. (manuscript in submission).

Grimes, J., Creech, S., Chokshi, N., Angermiller, S., Villa, E., Yates, J., Meagher, M. Noise Induced Stress Impacts Secondary Hyperalgesia in a Human Capsaicin Pain Model. Poster Presentation: American Pain Society Annual Meeting 2004.

Creech, S., Grimes, J., Meagher, M. Emotional Disclosure of Trauma Impacts Thermal Pain Sensitivity. Poster Presentation: American Psychological Society Annual Meeting 2004.

Awards:

Texas A&M University Student research week 2004: 1st place poster competition (Karlin, Creech, Grimes, Clark, Morey & Meagher), 2nd place poster competition (Creech, Grimes & Meagher)

Texas A&M Faculty of Neuroscience Travel Award, 2004

American Psychological Society Student Travel Award, 2004

Texas A&M Department of Psychology Student Travel Award, 2003, 2004