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Disclosure and Health: Enhancing the Benefits of Trauma Writing Through Response Training

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DISCLOSURE AND HEALTH: ENHANCING THE BENEFITS OF TRUAMA WRITING THROUGH RESPONSE TRAINING

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

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Abstract

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Writing about a personal traumatic event has been found to have psychological and physical health benefits. Focusing on traumatic memories in writing may be a form of exposure. In imagery exposure and trauma writing, greater physiological reactivity was predictive of better outcomes. Given the importance of physiological output in emotional processing, response training was developed and found to be effective in increasing appropriate physiological reactivity in imagery exposure. If response training amplifies physiological reactivity and the benefits of writing, the hypothesis that writing is a form of exposure would be strengthened, and training may be a valuable tool to improve the efficacy of psychotherapy approaches that use writing as a form of exposure.

The present study examined whether response training enhances the benefits of trauma writing. In this study, participants wrote for 20 minutes on three occasions about a personal traumatic event (n = 113) or a trivial topic (n = 133) and received response imagery training (n = 79), stimulus imagery training (n = 84) or no training (n = 83). Heart rate and skin conductance were recorded in sessions one and three throughout a 10-minute baseline, writing, and a ten-minute recovery period. Self-reported trauma symptoms and emotion were assessed in each session. One month after completing the sessions, participants completed follow-up assessments of psychological and physical health outcomes. As predicted, trauma writing elicited greater physiological reactivity and self-reported trauma symptoms and emotion than neutral writing. Response training amplified physiological reactivity to trauma writing more than neutral writing, without amplifying levels of self-reported emotion or trauma symptoms. The physiological reactivity and self-reported emotion elicited by trauma writing habituated across sessions and response training enhanced these effects. Finally, increased heart rate predicted better outcomes for all trauma writers; however, response trained trauma writers who evidenced greater heart rate showed the greatest reductions in trauma, depression and physical illness symptoms at follow-up. These results support previous research which found that greater physiological reactivity was predictive of writing outcomes. The findings are the first to demonstrate that response training facilitates emotional processing and thus may be a beneficial adjunct to trauma writing.

Disclosure and Health: Enhancing the Benefits of Trauma Writing Through Response Training

Two decades of research suggests that writing about a personal traumatic event has psychological and physical health benefits (Frattaroli, 2006; Pennebaker & Seagal, 1999). Currently, writing is used as a form of exposure treatment in some psychotherapy approaches to trauma symptom reduction (Nishith, Resick, & Griffen, 2002; Resick & Schnicke, 1992). While preliminary research suggests that writing is a form of exposure (Epstein, Sloan, & Marx, 2005; Sloan & Marx, 2004b; Sloan, Marx, & Epstein, 2005) more empirical research is required to ensure the accuracy of this assumption to broaden writing's clinical utility and clarify when and for whom writing may be beneficial.

The bio-informational theory of emotion (Lang, 1979) may serve to elucidate the mechanism by which trauma writing is effective, and thus how its clinical utility may be improved. From the perspective of bio-informational theory, traditional imagery processing exposure is similar to writing, in that both are media through which memory networks can be accessed. An emotional memory network is comprised of mutually connected information units, including descriptive, meaning, and response units. While descriptive and meaning units are typically easily accessed, individuals often have difficulty accessing response units, as evidenced by low physiological reactivity (Lang, Levin, Miller, & Kozak, 1983; Marks & Huson, 1973; Weerts & Lang, 1978). For complete emotional processing to occur, all three units (descriptive, meaning, and response) must be fully activated (Lang, 1979). As the theory would predict, low physiological reactivity during exposure is associated with poor therapy outcomes, whereas high physiological reactivity (reflecting response unit activation) is associated with good outcomes (Beckham, Vrana, May, Gustafson, & Smith, 1990; Foa & Kozak, 1986; Lang, Melamed, & Hart, 1970; Watson & Marks, 1971). The positive association between physiological responding and outcomes was found in both imagery processing and writing studies (Epstein et al., 2005; Sloan et al., 2004b; Sloan et al., 2005), suggesting that both techniques serve as media through which memory networks are activated and processed. Given the importance of physiological output in emotional processing, a response training technique was developed, and has been found to be effective in helping increase appropriate physiological reactivity in imagery processing exposure (Lang, Kozak, Miller, Levin, & McLean, 1980; Miller, Levin, Kozak, Cook III, McLean, & Lang, 1987).

In the present study, participants received either response or stimulus training and were then asked to write about either a personal traumatic event or a neutral topic while physiological reactivity is recorded. Depression, trauma and physical illness symptoms were assessed at baseline and one-month post writing and trauma symptoms were also assessed after each writing session. The hypothesis that writing is a form of exposure would be strengthened empirically if response training, which was developed to improve exposure outcomes, also amplifies the benefits of writing. Further, if the benefits of writing are enhanced with this technique, then training may be a valuable tool to improve the efficacy of psychotherapy approaches that use writing as a form of exposure. In order to further clarify the connections between trauma writing and the response training procedure, the writing paradigm, bio-informational theory of emotion and response training literatures are reviewed below.

Review of the Literature

Writing Paradigm Research and Theory

Two decades of research utilizing the writing paradigm, developed by Pennebaker, indicates that disclosure of traumatic experiences through writing has far-reaching physical and mental health benefits (Pennebaker et al., 1999). A recent meta-analysis of writing studies (Smyth, 1998) found a moderate effect size (d = .47), which reflects a 23% symptom improvement in the traumatic disclosure group over the neutral topic disclosure group. As suggested by Smyth and Pennebaker (2001), the efficacy of the writing paradigm is impressive, as a meta-analysis of psychotherapy outcomes (Smith & Glass, 1977) reported an average 32% greater improvement for individuals receiving psychotherapy compared to those who did not. Writing's efficacy, efficiency (in studies, writing typically takes place in three to seven sessions for 15-20 minutes each, compared to psychotherapy averaging 11 sessions for 40 – 50 minutes each), and cost-effectiveness suggests that writing as a medium for disclosing traumatic events may be a potent adjunct to traditional therapy.

The written disclosure paradigm has been widely used with college students who are asked to write about a neutral event or their deepest thoughts and feelings about an extremely important emotional issue that has affected their life. In the current study, a college student population will be used. As such, the empirical evidence of the psychological and physical health benefits of trauma writing among college student populations will be reviewed.

Among college student populations, a number of studies have linked written disclosure of traumatic experiences with improvements in physical health. Writing about an emotional issue has been found to be associated with significant drops in physician visits compared to writing about a neutral topic. Decreases in physician visits have been observed at two months after writing (Pennebaker & Francis, 1996; Pennebaker, Kiecolt-Glaser, & Glaser, 1988), at six months after writing (Pennebaker & Beall, 1986; Pennebaker, Colder, & Sharp, 1990), and at 1.4 years after writing (Pennebaker, Barger, & Tiebout, 1989). Further, compared to writing about a neutral topic, writing about a traumatic event has been associated with greater reductions in self-reported physical illness symptoms at one (Epstein et al., 2005; Sloan et al. 2004b; Sloan, et al., 2005) and two months (Sloan et al., 2005) post writing. Trauma writing has also been found to be associated with reductions in physiological reactivity across sessions. Heart rate, skin conductance, and cortisol levels were found to decrease across trauma writing sessions, whereas for the neutral topic controls there were no significant decreases (Sloan, Marx, Epstein, & Lexington, 2007; Epstein et al., 2005; Petrie, Booth, Pennebaker, Davison, Thomas, 1995; Sloan et al., 2005). Additional studies have found that writing about emotional topics can benefit immune system functioning. Beneficial effects from trauma writing have been found with antibody response to the Epstein-Barr Virus (Esterling, Antoni, Fletcher, Marguiles, & Schneiderman, 1994; Lutgendorf, Antoni, Kumar, & Schneiderman, 1994), antibody response to Hepatitis B vaccinations (Petrie et al., 1995), and CD-4 (t-lymphocyte) levels (Booth, Petrie, & Pennebaker, 1997). In summary, the physical benefits of disclosing a traumatic event through writing appear to be far reaching and include decreased doctor visits, physiological arousal, and self-reported symptoms of physical illness, as well as improved immune functioning.

Trauma writing has also been found to have short and long term psychological effects. Trauma writing participants have reported higher levels of negative mood (Donnelly

& Murray, 1991), sadness and guilt (Petrie et al., 1995), unpleasantness and arousal (Sloan et al., 2005; Sloan & Marx, 2004b), and fear, anxiety, and depression (Greenberg, Wortman, & Stone, 1996) immediately after writing compared to controls who wrote about a neutral event. However, across sessions, trauma writing participants evidenced declines in negative mood, and unpleasantness and arousal compared to neutral topic controls (Smyth, Hockemeyer, & Tullouch, 2008; Sloan et al., 2005; Sloan & Marx, 2004b; Donnelly et al., 1991). Further, across sessions, trauma writing participants reported a more positive attitude of themselves and their topics and the degree to which the topic was painful or upsetting decreased (Donnelly et al., 1991). Trauma writing has also been found to be associated with long-term psychological benefits. In particular, from before to one month following writing, trauma writers evidenced greater reductions in self-reported trauma and depression symptoms than neutral writers (Sloan et al., 2004b; Sloan, et al., 2005). At 1.5 months post writing, trauma writers were also found to report less avoidant behavior, fewer intrusive thoughts, and fewer depression symptoms than neutral writers (Schoutrop, Lange, Hanewald, Davidovich, Salomon, 2002). Moreover, at two months post writing, trauma writers reported fewer intrusive thoughts and less avoidant thinking than neutral writers (Klein & Boals, 2001). Finally, trauma writers reported significant reductions in distress and event-related intrusive/avoidant thinking from baseline to a four-month follow-up (Park & Blumberg, 2002). In summary, trauma writing has been found to increase negative affect immediately after writing, however, across sessions, negative mood has been found to decrease. Moreover, many weeks after writing, trauma writers reported less avoidant behavior, and reductions in post-traumatic and depression symptoms compared to neutral writers, which suggests that trauma writing leads to long-term psychological improvements.

While trauma writing has been found to lead to improvements in psychological and physical health in many studies, only a few studies that have examined the effect of trauma writing on individuals with a diagnosis of post-traumatic stress disorder (PTSD), and the results of these studies have been mixed. One reason for the mixed results may be that these studies have not followed the standard writing paradigm instructions. In one study, individuals with PTSD were randomly assigned to either a trauma writing (n = 8) or a neutral writing (n = 6) condition and wrote on three occasions in their own home (Gidron, Peri, Connolly & Shalev, 1996). In addition to writing, individuals in the trauma writing group were asked to orally elaborate on their most severe trauma. At five weeks post writing, trauma writers evidenced an increase in health care visits and avoidance symptoms compared to neutral writers. Given the departure from the standard writing paradigm instructions, and the fact that writing took place in a non-controlled environment, it is difficult to know which aspect of disclosure or of the setting contributed to the negative outcomes for trauma writers. In a more recent study, participants diagnosed with PTSD (n = 25) were randomly assigned to either a trauma or neutral writing condition and wrote on three occasions (Smyth et al., 2008). In this study, the standard writing paradigm instructions were altered in that they progressed from relatively unstructured to more structured by the last session to facilitate narrative formation. At a three month follow-up, trauma writing led to improved scores on a measure of post traumatic growth, and greater reductions in tension and anger than neutral writing. Further, trauma writing led to a trend toward greater reductions in depression symptoms, and neutral writing led to a trend toward improved health. Finally, severity of post-traumatic symptoms decreased in both writing groups at follow-up, although not significantly. Again, given the fact that the writing instructions were altered in this study, it is difficult to conclude from these results whether the standard writing paradigm may have beneficial effects for individuals with a diagnosis of PTSD.

For other individuals who have a history of victimization, but not a PTSD diagnosis, unexpectedly, both trauma and neutral writing has been found to lead to improvements in health. In one study, female college students with a history of sexual assault wrote about either their most severe victimization or a neutral topic. Both trauma and neutral writing led to a significant decrease in post-traumatic and physical illness symptoms one month post-writing (Kearns, Edwards, Calhoun & Gidycz, 2010). The improvements seen across both writing conditions suggests that emotional disclosure produced positive benefits, but that emotional disclosure of sexual assault among college students does not produce any added health benefits beyond the benefits of writing about a neutral topic. A similar effect was found among a non-college student population. In a study of female prison inmates with a history of victimization, both trauma and neutral writing led to improvements in psychological and physical health seven weeks post-writing (Daniels, 2009). In a study of adult patients with PTSD, both the trauma and neutral writing groups evidenced a (non-significant) decrease in severity of post-traumatic stress symptoms at a three moth follow-up (Smyth et al., 2008). Together, these studies suggest that for certain types of individuals, both trauma and neutral writing may lead to psychological and physical health benefits, but the benefits of trauma writing do not outweigh the benefits of neutral writing.

While much research has focused on determining the benefits of writing, the mechanisms underlying its effectiveness are poorly understood (Sloan & Marx, 2004a). It is critical to clarify writings' curative factors and to clarify how individual differences may influence writings' efficacy, and thus which individuals are most likely to benefit from writing interventions. Furthermore, techniques may be devised to maximize the benefits of writing for those less likely to benefit. Several possible mechanisms of writing have been examined including emotion inhibition (Pennebaker et al., 1989; Pennebaker, Hughes, O'Heeron, 1987), cognitive adaptation (Pennebaker et al., 1997) and emotional processing/exposure (Kloss & Lisman, 2002; Sloan & Marx, 2004a; Sloan et al., 2005).

The Psychosomatic Theory of Inhibition (Pennebaker et al., 1989; Pennebaker & Susman, 1988) offers insight into the underlying physiological mechanisms at work during disclosure. The Psychosomatic Theory of Inhibition suggests that if individuals are unable or unwilling to disclose the emotions associated with a highly stressful event, physiological work is required to inhibit behavior, thoughts, and feelings related to the stressful event. Over time, the physiological work of inhibition acts as a low-level cumulative stressor. It is believed that the cumulative physiological stress of inhibiting increases the risk of physical illness. The theory suggests that disclosing previously undisclosed highly stressful experiences reduces the physiological stress of inhibition, and therefore leads to improvements in physical health. Suppression of emotion has been found to be associated with increases in sympathetic activation. Skin conductance levels increased when emotional expression was inhibited (Gross & Levenson, 1993) and when withholding the disclosure of highly stressful events (Pennebaker et al., 1987). In contrast, skin conductance levels decreased and were negatively correlated with health improvements when highly stressful events were disclosed (Pennebaker et al., 1989; Pennebaker et al., 1987). Other studies also found that writing about emotional topics can have beneficial effects on the functioning of the immune system. Beneficial effects from trauma writing have been found with antibody response to the Epstein-Barr Virus (Esterling et al., 1994; Lutgendorf et al., 1994), antibody response to Hepatitis B vaccinations (Petrie et al., 1995), and CD-4 (t-lymphocyte) levels (Booth et al., 1997). While the aforementioned studies link emotional disclosure to improvements in health, there is no evidence to support the hypothesis that a decrease in inhibition mediates the relation between writing about stressful/traumatic events and improved health.

A cognitive adaptation explanation for the curative mechanisms of writing suggests that trauma writing facilitates the construction of a narrative of a traumatic event, which allows the individual to organize and assimilate the event (Pennebaker, 1990). The cognitive assimilation of traumatic memories subsequently leads to decreased stress and improvements in health. The cognitive adaptation explanation has been tested by examining changes in word usage across writing sessions. Essays from six writing experiments were analyzed and revealed several interesting findings (Pennebaker et al., 1997). First, the more positive words used by the individuals, the healthier they were at a later period. Second, use of a moderate number of negative emotion words was associated with better health outcomes than use of a very high or a very low number of negative emotion words. Finally, people who began with a poorly organized story and progressed to a coherent description of the emotional event by the last day of writing showed the greatest improvements in health. This progression was evidenced by increased usage of both causal words (i.e., cause, effect, reason, and because) and insight words (i.e., realize, understand, think, and consider) throughout the writing period; increases in causal and insight words were positively correlated with improved health. It is important to note that these findings are only correlational and it is possible that the changes observed in word usage are not associated with cognitive adaptation, but are associated with another mechanism of change. One study directly examined the hypothesis that the creation of a narrative facilitates cognitive change. In this study (Smyth et al., 2001), participants were assigned to one of three conditions: 1) write about a traumatic event in a narrative fashion, as is typical in writing studies; 2) write about a traumatic event by listing thoughts, feelings and sensations about the event; 3) write about a neutral topic. At follow-up, trauma writers who wrote a narrative reported less restriction of activity due to illness than the other two groups. These results suggest that the process of constructing a narrative of a traumatic event may facilitate cognitive adaptation. However, other explanations of the findings are also possible. For example, it is possible that no beneficial effects were observed in the non-narrative condition because negative emotion was not elicited when traumatic experiences were disclosed in a fragmented manner. It is possible that the elicitation of emotion, rather than the creation of a narrative facilitates health improvements. One study tested the hypothesis that emotional expression is critical in facilitating health improvements (Sloan, et al., 2007). In this study, college students with a trauma history were randomly assigned to an emotional expression (EE) condition in which they were asked to write about a personal traumatic event with as much emotion as possible, an insight and cognitive assimilation (ICA) condition in which they were asked to write about a personal traumatic event with a focus on what the event meant to them, and to challenge their dissonant thoughts about the event or to a control condition in which they were asked to write about a neutral topic. Participants in the EE condition evidenced significantly greater HR reactivity to the first session, and significantly greater reductions in post-traumatic stress symptoms, depressive symptoms and physical health symptoms one month post-writing than the other two conditions. These findings suggest that emotional expression is a critical component of the effectiveness of trauma writing, and that cognitive adaptation alone does not account for the beneficial effects of trauma writing. Overall, there is a lack of conclusive evidence to support the cognitive adaptation theory.

The cognitive changes facilitated by writing may be the result of successful exposure (Foa & Kozak, 1986; Sloan et al., 2004b). Similar to exposure therapy, writing specifically targets traumatic memories and their emotional components (Largo-Marsh & Spates, 2002). As such, it is plausible that focusing on these targets in writing may serve as a form of exposure and that this exposure is an effective underlying mechanism of writing. The bio-informational theory of emotion (Lang, 1979) describes how emotional memories are processed in traditional exposure treatments and can serve to elucidate the mechanism by which trauma writing is effective. The theoretical framework of the bio-informational theory will be reviewed and support for the hypothesis that writing is a form of exposure will be examined in the context of this theory.

The Bio-Informational Theory of Emotion

According to this theory, developed by Lang (1979), emotions are action dispositions, which are elicited when a memory network is retrieved (Lang, 1979). An emotional memory network is comprised of mutually connected information units and is activated when a sufficient number of these units are stimulated by external input, such as language descriptions or pictures or by internal input, such as spontaneous associative links occurring in the brain, neuromuscular patterns, or autonomic states.

Three basic classifications of information units comprise a memory network: 1) stimulus units include representations of the perceived event (description); 2) response units, which activate output processes, including behavioral acts, physiological mobilization, and expressive, affective language; and 3) meaning units, which include declarative (semantic) knowledge. As the number of information units in the memory network activated by internal or external cues increases, the extent to which the memory episode is processed increases. To completely access and subsequently process a memory network, all three units (stimulus, response, and meaning) must be activated.

Individuals can typically activate the stimulus and meaning units of a memory network, but may have difficulty accessing the response units. According Lang (1984), stimulus and meaning units of an emotional memory network are often processed as "knowledge about" an emotional situation, independently of response unit processing. For example, individuals may provide verbal reports of subjective distress appropriate to an emotional situation, but lack corresponding levels of efferent output. In this situation, the individual is appraising the affective meaning of the event, but the somatic and visceral programs that comprise the response units of the network are not fully accessed, as evidenced by low physiological responding. Specifically, individuals have been found to vary in their physiological reactivity to scripts during imaginal exposure treatments with some individuals showing high reactivity, while others show very low reactivity (Lang et al., 1983; Marks et al., 1973; Weerts et al., 1978). In several experiments with phobic individuals, significantly greater heart rate reactivity was found to phobic than to neutral imagery in only three of the five experiments, and greater skin conductance reactivity to phobic than to neutral imagery was found in only two of these experiments (Marks et al., 1973). In another study, snake phobic and socially anxious students were asked to imagine their own and the other groups fear imagery situations, as well as non-fear control situations (i.e., exercise and neutral) (Lang et al., 1983). As expected each group rated their own fear imagery situation as more arousing. However, while each group showed a pattern of greater heart rate and skin conductance reactivity to their own fear imagery situations than to the other group's fear imagery, these differences were not significant. These findings suggest that individuals may report high levels of arousal to fear imagery, but fail to exhibit synchronous increases in efferent output.

The discrepancy between self-reported emotion and physiological reactivity has been found to vary based on trauma history. In one study, individuals with PTSD who were exposed to a single trauma, individuals with PTSD who were exposed to multiple traumas, and control participants who were never trauma exposed or were trauma exposed, but did not have PTSD, were asked to imagine personally threatening images and neutral events (McTeague, Lang, Laplante, Cuthbert, Shumen, & Bradley, 2010). Physiological responding and self-reported emotion were assessed. As expected, individuals with single-trauma PTSD and individuals with multiple-trauma PTSD reported greater levels of negative emotion than control participants in response to threat imagery. However, single-trauma PTSD participants showed significantly more robust heart rate and skin conductance reactivity than both the control and the multiple-trauma PTSD participants. In fact, multiple-trauma PTSD participants showed skin conductance reactivity during threatening imagery equivalent to that shown during neutral imagery, indicating that their physiological response to threatening imagery was blunted. Multiple-trauma participants in this study experienced a greater number of traumatic events which began at an earlier age, and their PTSD persisted an average of three times longer than single-trauma patients. Compared to single-trauma participants, multiple-trauma participants also had more severe PTSD that was concomitant with more severe anxiety and depression. Overall, these findings suggest that physiological reactivity is likely to be blunted among individuals with PTSD associated with recurrent trauma exposure, more severe anxiety and depression and lengthier chronicity of the disorder, whereas it is less likely to be blunted among individuals with single-trauma PTSD.

Blunting of physiological reactivity during aversive imagery has also been observed in patients with other broadly symptomatic anxiety disorders, such as generalized anxiety disorder, generalized social phobia with comorbid depression, and panic disorder with agoraphobia (Lang & McTeague, 2009; McTeague, Lang, Laplante, Cuthbert, Strauss, & Bradley, 2009; Cuthbert, Lang, Strauss, Drobes, Patrick, & Bradley, 2003). This physiological blunting is systematically more pronounced over the anxiety disorder spectrum as it has been found to be associated with greater chronicity, severity of symptoms, and negative affectivity, as well as poorer prognosis (Lang & McTeague, 2009). Taken together, these findings suggest that the long-term stress of more severe, enduring negative affectivity and dysfunction is likely to be associated with blunted efferent output.

As previously mentioned, efferent output is associated with treatment outcomes, such that individuals with greater physiological reactivity at the beginning of exposure have better outcomes than individuals who report high levels of arousal, but are not highly physiologically reactive at the onset of treatment (Beckham et al., 1990; Foa et al., 1986; Lang et al., 1970; Watson et al., 1971). In one study, physiological reactivity of snake phobics was assessed during systematic desensitization and it was found that individuals who had higher heart rates during the initial presentations of feared imagery, showed greater fear reduction across treatment as assessed by self-report and a behavioral avoidance test (Lang et al., 1970). In another study, physiological reactivity of specific phobics and agoraphobics was assessed during flooding and it was found that higher heart rate and skin conductance reactivity at the start of treatment predicted greater reductions in anxiety and avoidance

(Watson et al., 1971). Similarly, individuals with a phobia of flying who evidenced increases in heart rate during exposure that corresponded with high levels of self-reported anxiety evidenced greater reductions in fear than individuals who reported high levels of anxiety, but did not experience a corresponding increase in heart rate (Beckham et al., 1990). These findings are consistent with bio-informational theory, in that high levels of physiological arousal at the beginning of treatment suggest that the response units of the memory network have been accessed, thus the memory structure is available for modification, and good treatment outcome is possible. In contrast, a lack of physiological reactivity at the beginning of exposure treatment suggests that the memory network, the target of the exposure intervention, has not been fully accessed (the response units have not been activated), and therefore cannot be fully processed, resulting in poorer treatment outcome.

The above-mentioned studies used imagery as a medium to access memory networks. However, there are many paths to network activation, including language cues (Lang, Cuthbert, & Bradley, 1998). Language is not a necessary precursor for activation of an emotional memory network (Lang et al., 1998). However, language cues in spontaneous internal processing or external communication, symbolizing events and actions in an emotional memory, can stimulate action programs for muscles and glands in the same way these programs are stimulated by real-life events, indicating that language cues can serve as a medium of access to an emotional memory network and facilitate emotional processing (Lang et al., 1998).

Bio-informational Theory and Writing

As bio-informational theory would predict, writing about a trauma has been found to elicit physiological reactivity. Moreover, greater initial physiological reactivity to trauma writing was associated with positive outcomes (Sloan et al., 2004b). The written disclosure procedure has been found to evoke increased physiological reactivity among non-screened students. College students who were not screened for post-traumatic stress symptoms showed greater heart rate reactivity to the initial trauma writing session than control participants who wrote about a neutral topic (Epstein et al., 2005). Among these trauma writers, greater heart rate reactivity to the first session was associated with reductions in depression and physical symptoms at one month post writing (Epstein et al., 2005). The written disclosure procedure has also been found to evoke increased physiological reactivity among students screened for post-traumatic stress symptoms. In particular, female college students with at least moderate post-traumatic stress symptoms showed greater initial cortisol reactivity in response to trauma writing than control participants who wrote about a neutral topic. Among trauma writing participants, greater physiological reactivity to the first session was associated with reduced PTSD symptom severity (Sloan et al., 2004b; Sloan, et al., 2005) and depressive symptoms (Sloan et al., 2004b) at one and two months post writing. Further, in two case studies, the standard trauma writing instructions were given to two patients with moderate levels of PTSD symptoms (Sloan & Marx, 2006). Cortisol levels were assessed before and after writing in each of the three sessions. The first patient demonstrated increased cortisol reactivity in session one (which habituated by the third session), and a subsequent decrease in post-traumatic stress and depression symptoms at a two month follow-up. The second patient did not demonstrate increased cortisol reactivity in session one. Interestingly, compared to the first patient, the second patient reported a more extensive trauma history and more severe symptomatology, both of which have been associated with blunted physiological reactivity (McTeague et al., 2010). Further, as bio-informational theory would predict given this patient's lack of physiological response, no reductions in levels of post-traumatic stress and depression symptoms were evidenced at follow-up.

The association between initial increased physiology and positive outcomes in trauma writing mirror those of exposure studies (Lang et al., 1970; Watson et al., 1971), suggesting that writing is a form of exposure that provides an effective route through which to access memory networks and promote emotional processing. The above-mentioned writing studies finding a positive association between initial physiological reactivity and outcome used a repeated measures, three disclosure session design, thus allowing for habituation to occur (Epstein et al., 2005; Sloan et al., 2004b; Sloan et al., 2005). In exposure treatments, across sessions habituation has been found to be an indicator of positive outcomes (Foa et al., 1986). Similarly, across session habituation is an indicator of positive outcomes in trauma writing studies. In research finding beneficial effects for trauma writing participants, reductions in cortisol levels and heart rate were evidenced across sessions, whereas for the neutral topic controls there were no significant changes across sessions and no beneficial effects (Sloan, et al., 2007; Sloan et al., 2005). In another study, skin conductance levels were found to decrease significantly across sessions for trauma writing participants, but not for neutral topic controls (Petrie et al., 1995). Also, consistent with a reduction in physiological reactivity across sessions, no significant difference between the physiological reactivity of trauma writing participants and controls has been found in sessions two and three (Epstein et al., 2005; Sloan et al., 2005). Taken together, these findings indicate that trauma writing is like traditional exposure, in that both require across sessions habituation reduction in physiological reactivity for benefits to accrue.

How Can Efferent Output be Amplified to Maximize the Benefits of Writing?

Lang and his colleagues (1980) developed a brief response training program for imagery processing that increases efferent output, by amplifying pre-existing response dispositions. In this program, individuals are read scripts, asked to vividly imagine the event being described, and report the image in detail to the trainer. As the image is relayed, the trainer reinforces response details (i.e., actions performed by the subject or visceral or somatic responding) by encouraging the individual to include more response statements in subsequent images. Response training has been contrasted with stimulus training, which reinforces stimulus detail (e.g., a description of the color and size of an object).

The effect of training on physiological reactivity has been examined in several studies with college student populations. In one experiment, participants received relaxation training followed by either stimulus or response training (Lang et al., 1980). Participants were then asked to imagine three fear, action and neutral scenes while physiological responses were recorded. As predicted, response training, but not stimulus training, amplified situation-appropriate heart rate reactivity to fear and action scenes. In a similar study, snake phobic and socially anxious students received either response or stimulus training and were then asked to imagine their own and the other groups fear imagery situations, as well as non-fear control situations (i.e., exercise and neutral) (Lang et al., 1983). Response-trained individuals showed greater heart rate reactivity than individuals who were stimulus trained or untrained to their own fear imagery situations, but not to the other group's fear imagery. The latter finding indicates that response trained individuals show different somato-visceral patterns of response to different images independently of specific response instructions, suggesting that the effect of response training is not to impose physiology on individuals, but rather to facilitate the access of perceptual-motor programs already present in memory (Lang, 1984).

The hypothesis that response training serves to access pre-existing response dispositions is further supported by evidence that physiological reactivity among response trained participants varies according to the contextual theme of the image, paralleling what would be expected to occur in real-life situations (Lang et al., 1983). Particularly, among response trained participants, fear scenes were accompanied by increases in heart and respiratory rates, whereas exercise scenes were accompanied by an increase in heart rate, greater muscle reactivity than that which occurred during fear scenes, and only small changes in respiration (Lang et al., 1983). Similarly, response trained, but not stimulus trained, participants showed more muscle tension during action than during fear scenes (Lang et al., 1980), and significantly faster respiratory rates during fear than during action scenes (Lang et al., 1980; Miller et al., 1987). Response trained participants also showed greater ocular activity during fear and action scenes than during neutral scenes, but stimulus trained participants did not (Miller et al., 1987). The specificity of these efferent output patterns suggests that response trained participants were not simply increasing physiological reactivity indiscriminately to any imagery command, but rather were responding in a thematically consistent way to proposition elements that were brought to the image from the individual's long-term memory (Lang et al., 1983).

Together, these findings indicate that response trained individuals show different somato-visceral patterns of response to different images and these patterns occur with specific image contents (i.e., muscle tension during exercise imagery or increased respiratory rates during fear imagery), as well as independently of specific response instructions. In other words, response training increases appropriate physiological reactivity by acting as an amplifier of pre-existing response dispositions.

Response training has been found to be particularly effective in amplifying physiological reactivity to personally relevant affective scenes among students with poor imagery ability (Miller et al., 1987). Individuals with poor imagery ability have more difficulty generating affect from linguistic representations through imagery than good imaginer's, as evidenced by low physiological responding, and therefore may require more personalized cues to be able to fully access emotional memory networks with language prompts. When standard fear, action and anger scenes were imagined before training, greater heart rate reactivity was exhibited for individuals with good imagery ability than for individuals with poor imagery ability, and these differences were enhanced after response training. In contrast, response training increased appropriate physiological reactivity among poor imaginers when personally relevant emotion scenes were imagined, indicating that individuals with poor imagery ability are better able to benefit from response training and generate affect from linguistic representations, as evidenced by physiological responding, when imagery scenes contain personally relevant cues rather than standard cues. (Miller et al., 1987). These findings are consistent with the bioinformational theory, which suggests that as the number of information units in the memory network activated by internal or external cues increases, as would be expected to occur when an imagery scene contains personalized rather than standardized cues, the extent to which the memory episode is accessed and subsequently processed would be expected to increase.

According to Lang (1984) "Since the quantity of matching propositions is key to prototype access, it would be expected that response training would have the same enhancing effect on physiological responding regardless of the input medium". As such, since response training amplifies pre-existing response dispositions for imagery processing exposure, it is reasonable to expect that response training will also amplify physiological response to writing about a traumatic event in which personalized narrative "scenes" are created and which, like imagery processing, serves to access memory networks as evidenced by physiological responding (Epstein et al., 2005; Sloan et al., 2004b; Sloan et al., 2005). If efferent output is amplified, the beneficial effects of writing would be expected to increase.

The effects of response training have been found to be greater for cardiovascular than for skin conductance responses during imagery processing (Lang et al., 1980; Lang et al., 1983). While response training, but not stimulus training, amplified situation-appropriate heart rate reactivity to fear and action scenes, skin conductance was appropriately greater in fear scenes than action or neutral scenes, but did not differ according to training condition (Lang et al., 1980). Moreover, response training increased heart rate, but not skin conductance, reactivity to personalized imagery scenes (Miller et al., 1987). Unlike heart rate, which is responsive to internal stimulation, skin conductance is primarily responsive to external stimulation and stimulus habituation (Lang et al., 1980). As such, heart rate responses reflecting response information in the image may be increased by the imagery processing task. In contrast, skin conductance responses may be attenuated during imagery because of the internal cognitive processing imagery requires. The process of generating an image from spoken text involves tuning out the external environment, the typical source of electrodermal stimulation. In support of this view, skin conductance, unlike other physiological measures, has been found to show greater reactivity during the reading of the script to the individual than during the imagery period (Lang et al., 1980; Lang et al., 1983).

However, for individuals with good imagery ability, response training was found to increase skin conductance reactivity to standard affective imagery scenes, which suggests that skin conductance changes are part of the processing of emotional imagery (Miller et al., 1987). According to Lang et al. (1983), theme-relevant electrodermal information is explicitly coded in emotional memory networks, and efferent evidence of this coding can be uncovered if external stimuli, such as visual media, are used to prompt the image (Lang et al., 1983). The process of writing about a traumatic event involves the creation of personalized narrative "scenes". Writing inherently requires response to the external environment, and provides a medium through which to access theme-relevant electrodermal responses coded in emotional memory networks. Consistent with Lang's view, trauma writing has been found to be associated with skin conductance response (Hughs, Uhlmann, & Pennebaker, 1994; Petrie et al., 1995), suggesting that trauma writing is an effective route through which to access skin conductance responses coded in emotional memory networks.

Statement of Problem

The broad goals of this project were to determine whether response training may be an effective mechanism for improving the effects of trauma writing and to expand knowledge about response training, evaluate the connection between trauma writing as a form of exposure and traditional imagery exposure, and begin an investigation of the use of trauma writing as a form of treatment. The objectives of this study were to investigate: 1) the influence of training (response, stimulus, or none) on initial heart rate (HR) and skin conductance (SC) to trauma writing and habituation of response from sessions one to three; 2) the effect of training (response, stimulus, or none) on post-traumatic symptom severity and frequency across sessions and one month after trauma writing, and on depression and physical illness symptoms one month after trauma writing.

Statement of Hypotheses

Given the literature review and the purposes of the study, the following hypotheses were proposed.

1) Trauma writing would increase HR and SC more than neutral writing.
2) Response training would increase HR and SC to trauma writing more than stimulus or no training, whereas no training condition differences were expected as a result of neutral writing.
3) Response training would lead to greater habituation to trauma writing, as evidenced by greater reductions in HR and SC, than stimulus or no training from session one to session three, whereas, no differences in habituation were expected among training conditions as a result of neutral writing.
4) Trauma writing would increase reported post-traumatic symptom severity and frequency more than neutral writing.
5) Among trauma writers, response training would lead to a greater increase in reported post-traumatic symptom severity and frequency than stimulus or no training, whereas no training condition differences were expected as a result of neutral writing.
6) Response training would lead to greater habituation to trauma writing, as evidenced by greater reductions in reported post-traumatic symptom severity and frequency, than stimulus or no training from session one to session three,

whereas, no differences in habituation were expected among training conditions as a result of neutral writing.

7) Trauma writing would decrease reported levels of pleasantness and increase reported levels of arousal more than neutral writing.

8) Among trauma writers, response training would lead to a greater decrease in reported levels of pleasantness and a greater increase in reported levels of arousal than stimulus or no training, whereas no training differences were expected as a result of neutral writing.

9) Response training would lead to greater habituation to trauma writing, as evidenced by greater increases in reported levels of pleasantness and greater reductions in reported levels of arousal, than stimulus or no training from session one to session three, whereas, no differences in habituation were expected among training conditions as a result of neutral writing.

10) Trauma writing would reduce trauma, depression and physical illness symptoms more than neutral writing from baseline to the one month follow-up.

11) Among trauma writers, response training would lead to greater reduction of trauma, depression and physical illness symptoms than stimulus or no training, whereas no training differences were expected as a result of neutral writing.

12) Among trauma writing participants, greater HR and SC in session one would be associated with greater reductions in each outcome variable (trauma, depression and physical illness symptoms). If response training enhances emotional processing, then it would be expected that the relation between initial

physiological reactivity (HR and SC) and psychological and physical health outcomes would be strongest among response trained trauma writers.

Method

Experimental Overview

Undergraduate students enrolled in introductory psychology courses were invited to participate in the study, which involved three lab sessions (within two weeks) and a one-month follow-up by mail. Participants were randomly assigned to one of six groups in a 3 Training x 2 Writing topic design. At session one, participants completed questionnaires which assessed demographic information, post-traumatic symptom severity and frequency, and depression and physical illness symptoms. Participants then received training (response, stimulus, or none) and were subsequently asked to write about either a personal traumatic event or a neutral topic while heart rate (HR) and skin conductance (SC) levels were recorded. In sessions two and three, participants were asked to write for 20 minutes (maintaining the same writing condition as assigned in session one) and at session three, HR and SC were again assessed. Post-traumatic symptom severity and frequency were assessed after each writing session. One month after session three, participants were mailed a follow-up survey, to assess post-traumatic symptom severity and frequency, depression and physical illness symptoms. The first lab session lasted approximately 1 hour and 50 minutes. Sessions two and three lasted about 30, and 45 minutes, respectively.

Participants

A power analysis using 0.80 power, a trauma writing effect size of 0.23 (Smyth, 1998), and an alpha level of 0.05 found that approximately 30 participants per group would be sufficient to find an effect, resulting in a total sample size of 180 (Cohen & Cohen, 2003). A power analysis of 0.80 power, an imagery response training effect size of 0.35 (Lang et al., 1983), and an alpha level of 0.05 found that approximately 14 participants per group would be sufficient to find an effect, resulting in a total sample size of 84 (Cohen et al., 2003). To obtain a viable sample size for the present study, total sample size estimates were averaged, yielding a total sample size of 132 participants. Attrition rates in previous trauma writing studies range from 4% (Sloan et al., 2004b) to 10% (Brown & Heimberg, 2001). To account for a 10% attrition rate, the protocol was administered individually and participants were enrolled until 145 completed the study. Given the preliminary data, the protocol was then administered to an additional 101 individuals to further increase statistical power. In total, 194 participants completed the study. Similar to procedures used by Epstein et al. (2005), participants in the Virginia Commonwealth University (VCU), Department of Psychology research pool (consisting of approximately 1,500 undergraduates per fall, spring, and summer semesters) took part in this study, and were asked to write about stories related to their lives. Participants were compensated with course credit, as is typical in trauma writing studies (Kloss et al., 2002; Pennebaker et al., 1986; Smyth, True & Souto, 2001).

Since the proposed study was the first to examine the influence of response training on trauma writing outcomes, a non-clinical population was used. Undergraduate students are an appropriate target population for a traumatic disclosure intervention, as 84% have experienced at least one event of an intensity level sufficient to potentially elicit PTSD, 33%

have experienced four or more traumatic events, and students who have experienced a traumatic event report higher levels of depression, anxiety, and PTSD symptoms than non-traumatized students (Vrana & Lauterbach, 1994). Another study of college students from diverse academic settings also found that 55.8% to 84.5% of students have experienced an adverse life event, which could potentially be related to the development of PTSD (Smyth, Hockemeyer, Heron, Wonderlich & Pennebaker, 2008). In this study, 11% reported subclinical symptoms of PTSD and 9% reported symptomatology indicative of clinical PTSD (Smyth et al., 2008). Similar to the research on college students, in the general population, 55% to 69% of adults have experienced an adverse life event that could potentially elicit PTSD, and the lifetime prevalence of PTSD is 9% (American Psychiatric Association, 2000; Norris, 1992). The similar prevalence rates of adverse events and PTSD among college students and among the general population suggest that research examining the effect of stressful life events on college student populations can likely be generalized to the general population. Furthermore, among undergraduate participants not screened for a trauma history, decreases in psychological and physical symptoms were found to be associated with initial increased physiological reactivity to trauma writing (Epstein et al., 2005). Finally, myriad studies have indicated that trauma writing significantly reduces psychological and physical symptoms in college student populations (see Sloan & Marx, 2004a for a review).

Based on prior studies, the research pool was expected to consist of 18-23 year-old students of whom 25% are men, 75% women, 50% Caucasian, and 50% minority (largest minority African-American, 30% of total population). Although it has been suggested that trauma writing has differential gender effects (Smyth, 1998), recent findings (Epstein et al., 2005) indicate no gender differences in psychological or physical outcomes. As such, both men and women were included in the proposed study, and assigned to groups in equal proportions.

Materials

Physiological measures. To simplify and streamline the data collection process, physiological measures were assessed at sessions one and three only. Consistent with previous research, heart rate and skin conductance were recorded continuously for a ten-minute baseline period prior to writing, during the 20 minute writing session, and for a five-minute recovery period post-writing (Epstein et al., 2005).

Heart Rate (HR): EKG was recorded using sensors attached immediately below the participants' right clavicle and lowest left rib. The EKG R-wave triggered a digital input on the computer, which recorded the interbeat interval (IBI) in milliseconds. IBIs were converted off-line to HR.

Skin Conductance (SC): SC was recorded using a Coulbourn Skin Conductance Coupler. Participants were asked to wash their hands with tap water and electrodes filled with lubricant were attached. Pilot work was conducted to determine an appropriate electrode attachment location on the palm of the non-dominant hand that would not be influenced by the physical movement of writing.

Self-report measures. Consistent with previous writing studies (Sloan et al., 2004b), participants were asked to complete a demographic questionnaire (see Appendix A). The following measures were also administered most of which have been used in writing studies (Epstein et al., 2005; Sloan et al., 2004b; Sloan et al., 2005).

Davidson Trauma Scale: (DTS) The DTS (Davidson, Book, Colket, Tupler, Roth, David, et al., 1997) (see Appendix B) assesses severity and frequency of PTSD symptoms experienced in the last week. Each of the 17 items corresponds to one of the DSM-IV PTSD symptoms. The internal reliability and the two-week test-retest reliability of the DTS are 0.99 and 0.86, respectively. Consistent with previous research, the short version of the DTS was also used to assess changes in severity and frequency of PTSD symptoms ten minutes after recall of a trauma (McCleron, Beckham, Mozley, Feldman, Vrana, Rose, 2005) (see Appendix C).

Center for Epidemiological Studies-Depression Scale (CES-D): The CES-D (Radloff, 1977) (see Appendix D) is a 20-item self-report measure which assesses symptoms of depression in the general population and has high internal consistency.

The Pennebaker Inventory of Limbic Languidness (PILL): The PILL (Pennebaker, 1982) (see Appendix E) assesses the frequency of common physical symptoms and sensations. The Cronbach Alpha of the PILL ranges from 0.88 to 0.91, and the two-month test-retest reliability ranges from 0.79 to 0.83.

Self-Assessment Manikin (SAM): The SAM (Bradley & Lang, 1994) (see Appendix F) assesses subjective valence (pleasantness) and arousal. These dimensions have been found to reliably co-vary with physiological reactions associated with emotional experience, suggesting that the SAM is a valid measure of emotional responding (Bradley, Greenwald, Petry & Lang, 1992).

Training and writing conditions. Participants were randomly assigned to one of six groups in a 3 Training Condition x 2 Writing Condition design. A training session lasting approximately 45 minutes was conducted individually by the principal investigator or a trained research assistant following procedures outlined in previous studies (Miller et al., 1987; Peasley-Miklus & Vrana, 2004). Four action-oriented scripts, which lack reference to emotion but contain descriptive detail and reference to behavioral and physiological responding, or four action-oriented scripts, which lack reference to emotion but contain stimulus detail, were read by the investigator (see Appendix G). After each script was read, participants were asked to imagine the script and to describe their imagery.

Response Training: Participants were systematically praised for providing imagery descriptions of active physiological and behavioral involvement, including verbal responses (i.e. I scream), overt motor acts (i.e. I run away), and responses of the physiological organs (i.e. my heart is racing) (Lang, 1977). If participants did not provide descriptions of behavioral/physiological details, they were encouraged to do so for the remaining trials. Research has shown that response training increases physiological responding during emotion imagery (Lang et al., 1980; Miller et al., 1987) and was the condition predicted to augment physiological responses and the benefits of trauma writing.

Stimulus Training: Participants were systematically praised for providing imagery descriptions focusing on sensory detail, such as descriptors (i.e. the sky is blue or the sun is shining) (Lang, 1977). In contrast to response training, stimulus training has not been found to increase physiological responding during imagery (Lang et al., 1980; Miller et al., 1987). The stimulus training condition was used to observe the effect of training participants to attend or focus during writing.

No Training: Participants received no imagery training. The no training condition allows for direct replication of traditional writing paradigm procedures, and the stimulus training condition provides an equivalent treatment condition against which the response training condition can be compared.

Upon entering the laboratory at session one, all participants in the study completed several questionnaires, which took approximately 30 minutes. Adaptation periods in studies assessing psychophysiological parameters rarely last more than 20 minutes (Linden & McEachern, 1985). Therefore, participants in the no training control condition had ample time to adapt to the laboratory environment before psychophysiological baseline data was collected. There is great variability in definitions of psychophysiological baselines, however, the most frequently used definition is the mean of baseline minutes one through five (Linden et al., 1985). In the present study, HR and SC baseline data were collected for ten minutes so that baseline patterns could be examined to determine whether the participant was still habituating, and baseline was defined as the mean of baseline minutes six through ten.

To be consistent with typical writing paradigm studies (Epstein et al., 2005, Esterling et al., 1994; Sloan & Marx, 2004a; Sloan et al., 2004b), participants were asked to write on three separate days (within two weeks) for 20 minutes each session. Although standard instructions for the writing paradigm (Pennebaker, 1997) allow individuals to write about different topics each session, greater physiological reactivity and subsequent improvements in psychological and physical health have been found among participants who wrote about the same traumatic experience during each writing session compared to individuals who wrote about a different traumatic experience each session or a neutral topic (Sloan et al., 2005). As such, participants in the trauma writing condition were asked to write about the same traumatic experience in each writing session. Writing instructions were also adapted from instructions developed by Pennebaker (1997), with the addition that participants in the stimulus and response training conditions were instructed to "use the techniques you were taught earlier (or in the first session) in order to more fully involve yourself in your writing" (see Appendix H).

Emotional Disclosure: Participants were asked to write about the most traumatic/distressing experience of their lives with as much emotion and feeling as possible. Brief writing about a personal traumatic event was found to be associated with increased physiological response, and psychological and physical health benefits (Epstein et al., 2005; Sloan et al., 2004b; Sloan, et al., 2005).

Neutral Topic Control: Participants were asked to write about the details of how they spend a typical day without describing any emotion or opinions. Neutral topic writing has not been found to be associated with psychological or physical health benefits (see Sloan & Marx, 2004a for a review), and was used to observe the effects of non-emotional writing.

Procedures

The first lab session lasted approximately 1 hour and 50 minutes. Sessions two and three lasted about 30, and 45 minutes, respectively.

Manipulation Check: To test the intended effects of trauma writing the SAM was administered before and after each writing session to assess valence and arousal.

Session One: Upon arrival, participants were asked to read and sign the consent form. Participants filled out the demographic questionnaire the CES-D, DTS, the PILL and the SAM. Participants then received response, stimulus, or no training. Next, the electrodes were attached, which participants were told would record their bodily reactions. As in previous research (Epstein et al., 2005), participants were then instructed to relax by focusing on their breathing and clearing their mind of all thoughts. Baseline measures for HR and SC were then recorded continuously for ten minutes, after which participants wrote for 20 minutes, about either a personal traumatic event or a neutral topic, while physiological measures were continuously recorded. After writing, participants sat quietly for five minutes while recovery data was collected. The electrodes were then removed and the SAM and the DTS-short version were completed. Participants were then asked to return to the lab for their next scheduled writing session (each session occurred on a separate day within two weeks).

Session Two: To simplify and streamline the data collection process, physiological data was not recorded during session two. Participants were asked to complete the SAM. Participants were then provided with the same writing instructions as in session one and wrote for 20 minutes. The SAM and the DTS-short version were again completed and participants were asked to return for the last session.

Session Three: This was the same as session two, except that physiological measures were once again collected. Participants were then told that they would receive a follow-up survey via mail in one month and that debriefing would occur via e-mail after data collection was complete.

One Month Follow-Up: As in prior studies (Brown et al., 2001; Epstein et al., 2005; Greenberg et al., 1996; Sloan et al., 2004b), one month after writing, participants were mailed a follow-up survey including the CES-D, DTS, and the PILL.

Data Analysis Plan

Dependent measures included: 1) HR and SC change scores (mean of minutes 3-8 of writing minus mean of last five minutes of baseline, mean of minutes 9-14 of writing minus mean of last five minutes of baseline, mean of minutes 15-20 of writing minus mean of last five minutes of baseline). In total, six change scores (three change scores from session one and three change scores from session three) were calculated for HR and six change scores were calculated for SC; 2) PTSD symptom severity and frequency at post-session one, post-session two, and post-session three; 3) Valence and arousal change scores (post-session minus pre-session) for each session. In total, six change scores (three change scores for valence and three change scores for arousal) were calculated; 4) Change scores (follow-up minus baseline) for post-traumatic symptom severity and frequency, depression and physical illness symptoms.

To test hypotheses 1, 2 and 3, a regression model with correlated error structure analysis was conducted, using the mean of baseline session one and the mean of baseline session three as covariates to control for baseline differences. Consistent with previous research (Epstein et al., 2005; Konig et al., 2005; Pennebaker et al., 1987), baseline means for HR and SC were determined by calculating the mean of the last five minutes of baseline (minutes six through ten). To avoid error associated with the beginning of writing, the physiological data from the first and second minutes of writing were not included in analyses and the remainder were divided into three six minute segments (minutes 3-8, 9-14, and 15-20 of writing). The independent variables included were Writing Condition (trauma, neutral), Training Condition (response, stimulus, no training), Session (session one, session three), and Period nested within session (minutes 3-8; minutes 9-14; and minutes 15-20). The dependent variables included were six difference scores (three difference scores from session one and three difference scores from session three). For the tests of fixed effects in this analysis, the denominator degrees of freedom are not integers. This is because these statistics do not have exact F distributions. The values for denominator degrees of freedom are obtained by a Satterthwaite approximation, which does not assume equal variances.

To test Hypotheses 4, 5, and 6, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) x 3 Session (session one, session two, session three) repeated measures ANOVA was conducted. To test hypotheses 7, 8 and 9, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) x 3 Session (session one, session two, session three) x 2 Time (pre-writing, post-writing) repeated measures ANOVA was conducted. To test Hypotheses 10 and 11 for trauma, depression and physical illness symptoms, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) x 2 Interval (baseline, one-month follow-up) repeated measures ANOVA was conducted.

Hypothesis 12 was that among trauma writing participants, greater HR and SC in session one would be associated with greater reductions in each outcome variable (trauma, depression and physical illness symptoms). To test hypothesis 12, Pearson correlations were computed for trauma writing participants only. Pearson correlations between HR and SC difference scores for writing session one (mean of minutes 3-8 of writing minus mean of last five minutes of baseline, mean of minutes 9-14 of writing minus mean of last five minutes of baseline, mean of minutes 15-20 of writing minus mean of last five minutes of baseline), and difference scores for each of the outcome measures (follow-up minus baseline) were computed. Pearson correlations between HR and SC baseline scores for session one, and difference scores for each of the outcome measures (follow-up minus baseline) were also computed. Finally, a variable for stimulus training and a variable for response training were created using dummy coding, and Pearson correlations were computed between each of these dummy coded variables and difference scores for each of the outcome measures (follow-up minus baseline).

Next, to test Hypothesis 12, for trauma writing participants, a stepwise regression analysis was conducted regressing post minus pre difference scores for each of the outcome measures (PTSD symptom severity and frequency, depressive and physical symptoms) onto the HR and SC session one difference scores, HR and SC session one baseline scores, the dummy coded response and stimulus training variables[1], and the interaction of the dummy-coded group variables with each of the eight physiological independent variables. In order to assist with interpretation, if an interaction term entered in the stepwise regression analysis without its constituent main effects, a simultaneous regression was conducted to include all significant terms (interactions and main effects) plus all the main effects constituting the interactions.

Results

Demographics

Table 1 summarizes demographic characteristics for the entire sample and separately for each group. Overall, participants were mostly females (72%); in their early twenties (mean 21.5 years, S.D. = 5.5); were college freshmen or sophomores (57.7%); and generally identified English as their first language (85.8%). The sample was ethnically diverse. 48% identified their race as White; 28% as Black; 11% as Asian; 2% as Hispanic; 1.2% as Native Hawaiian or other Pacific Islander; and 9.8% as Other.

Comparisons for participants randomized to each group were made using one-way ANOVAs for continuous measures (age) and chi-square analyses for categorical measures (gender, race, year in school and native language). Only one group difference was found, as

[1] The response training variable and stimulus training variable were created using dummy coding. For the response training variable, response trained participants were assigned a 1, and stimulus and no training participants were assigned a 0. For the stimulus training variable, stimulus trained participants were assigned a 1 and response and no training participants were assigned a 0.

Table 1.

Demographic Information

Variable	Response Trained Trauma *N (%) or M (SD)*	Stimulus Trained Trauma *N (%) or M (SD)*	No Training Trauma *N (%) or M (SD)*	Response Trained Neutral *N (%) or M (SD)*	Stimulus Trained Neutral *N (%) or M (SD)*	No Training Neutral *N (%) or M (SD)*	Total Sample *N (%) or M (SD)*
Age	20.9 (4.2) *(Range 18-37)*	20.9 (2.8) *(Range 18-28)*	23.9 (9.8) *(Range 18-53)*	20.8 (4.3) *(Range 18-26)*	21.1 (4.7) *(Range 18-43)*	21.4 (4.0) *(Range 18-35)*	21.5 (5.5) *(Range: 18-53)*
Gender							
Male	9 (22.5%)	9 (25.7%)	10 (26.3%)	10 (25.6%)	10 (20.4%)	21 (46.7%)	69 (28%)
Female	31 (77.5%)	26 (74.3%)	28 (73.7%)	29 (74.4%)	39 (79.6%)	24 (53.3%)	177 (72%)
Race							
White	23 (57.5%)	16 (45.7%)	19 (50.0%)	23 (59.0%)	19 (38.8%)	18 (40.0%)	118 (48%)
Black/African American	8 (20.0%)	11 (31.4%)	8 (21.1%)	7 (17.9%)	19 (38.8%)	16 (35.6%)	69 (28%)
Asian	4 (10.0%)	4 (11.4%)	2 (5.3%)	6 (15.4%)	5 (10.2%)	6 (13.3%)	27 (11%)
Hispanic	1 (2.5%)	1 (2.9%)	1 (2.6%)	1 (2.6%)	0 (0.0%)	1 (2.2%)	5 (2%)
Native Hawaiian or Other Pacific Islander	1 (2.5%)	0 (0.0%)	1 (2.6%)	0 (0.0%)	0 (0.0%)	1 (2.2%)	3 (1.2%)
Other	3 (7.5%)	3 (8.6%)	7 (18.4%)	2 (5.1%)	6 (12.2%)	3 (6.7%)	24 (9.8%)
Year in School							
Freshman	14 (35.0%)	9 (25.7%)	12 (31.6%)	15 (38.5%)	19 (38.8%)	23 (51.1%)	92 (37.4%)
Sophomore	13 (32.5%)	7 (20.0%)	8 (21.1%)	9 (23.1%)	6 (12.2%)	7 (15.6%)	50 (20.3%)
Junior	8 (20.0%)	7 (20.0%)	5 (13.2%)	5 (12.8%)	9 (18.4%)	7 (15.6%)	41 (16.7%)
Senior	5 (12.5%)	12 (34.3%)	13 (34.2%)	10 (25.6%)	15 (30.6%)	8 (17.8%)	63 (25.6%)
Native Language							
English	35 (87.5%)	32 (91.4%)	27 (71.1%)	35 (89.7%)	45 (91.8%)	37 (82.2%)	211 (85.8%)
Other	5 (12.5%)	3 (8.6%)	11 (28,9%)	4 (10.3%)	4 (8.2%)	8 (17.8%)	35 (14.2%)

participants in the no training condition were marginally significantly older [M = 22.68, SD = 9.34] than response [M = 20.86, SD = 9.50] and stimulus [M = 20.98, SD = 9.34] trained participants, $F(2, 244) = 2.87$, $p = .06$.

Attrition

As depicted in Figure 1, rates of compliance across all conditions was quite high, with almost all of the participants (n = 240; 97.6%) completing more than one writing session. 97.3% of trauma writing participants (n = 110) and 97.7% of neutral writing participants (130) completed at least two writing sessions. A majority of the participants (n = 234; 95.1%) completed all three writing sessions (n = 107 trauma writing participants [94.7%] and n = 127 neutral writing participants [95.5%]). The remaining n = 194 (78.9%) participants completed all three writing sessions and the one month follow-up. For analyses that included only the physiological data (HR or SC), or within session measures of psychological reactivity to writing, the 234 participants who completed all three writing sessions were used in analyses. For analyses that included the follow-up measures of psychological or physical health, the 194 individuals who completed all three writing sessions and the follow-up were used.

Preliminary Data Screening

Physiological data. Outliers, skewness and kurtosis were examined using SPSS 18.0 Descriptives, Frequencies, and histograms (SPSS inc., Chicago, IL) for HR and SC data. For HR and SC, the mean of the last five minutes of baseline was examined. To avoid error associated with the beginning of writing, the first and second minutes of writing were not included in analyses, and the remainder was divided into six segments. The means of minutes three through eight, nine through fourteen, and fifteen through twenty of writing were

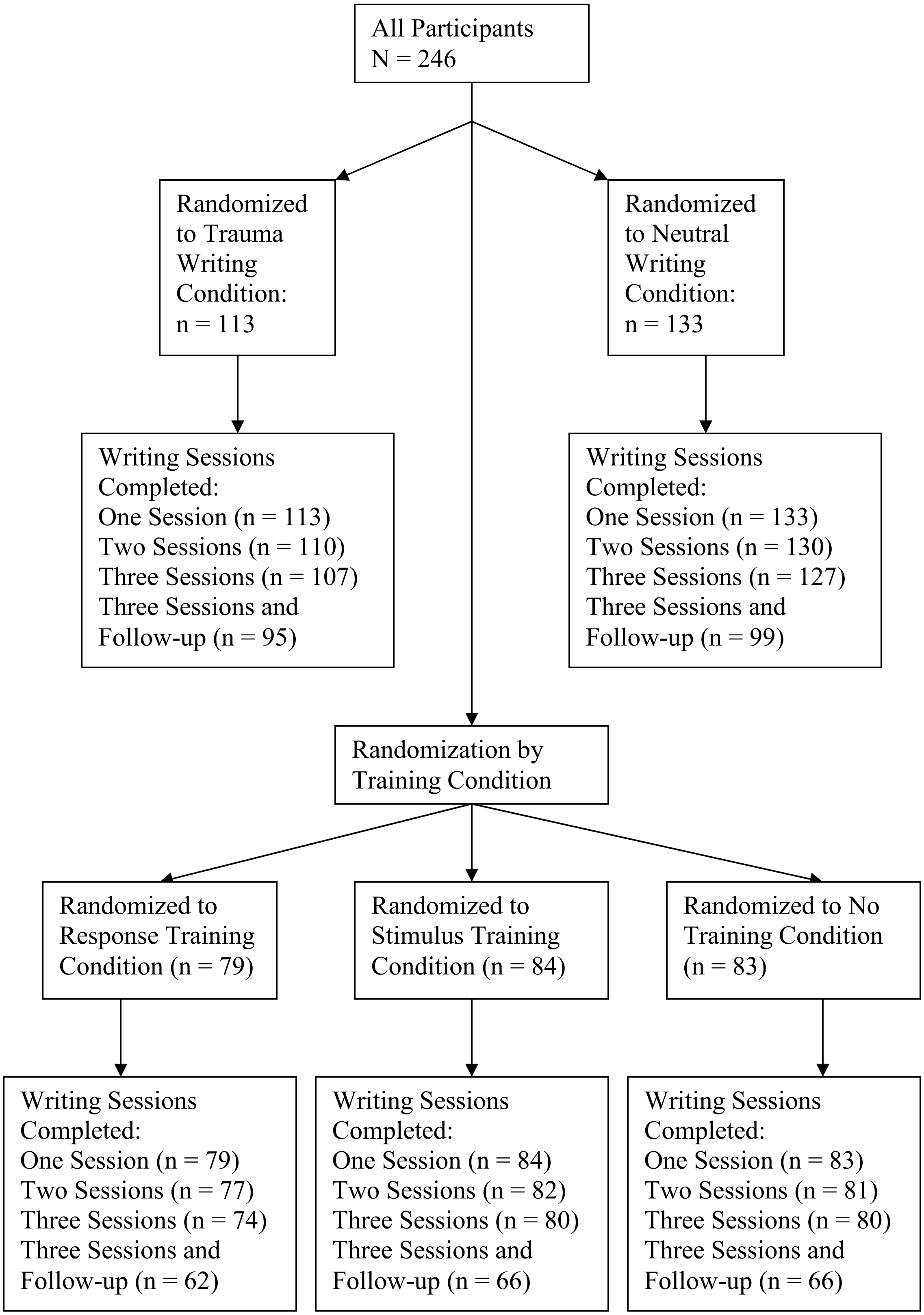


Figure 1. Compliance Rates

examined. For HR, no significant outliers were detected and kurtosis was within acceptable limits considering the sample size (Tabachnick & Fidell, 2001). As is often the case, the SC distribution was positively skewed. Thus, as recommended, a log 10 transformation was performed (Field, 2005). Using the transformed SC data, no significant outliers were detected and kurtosis was within acceptable limits considering the sample size (Tabachnick & Fidell, 2001).

Writing Condition x Training Condition x Session (1 and 3) analyses were run with baseline scores as dependent measures to examine whether there were significant baseline differences between participants randomized to the trauma and neutral writing groups and to the response, stimulus, and no training groups for HR and SC (see Table 2). Baseline HR increased from session one to session three, Session $F(1, 211) = 18.28$, $p < .01$. From session one to three, baseline HR increased for stimulus and no training participants, whereas response-trained participants showed no significant change, Session x Training Condition $F(2, 211) = 2.92$, $p = .056$. No other significant HR baseline differences were found.

Response-trained and no training participants had higher SC baseline scores than stimulus-trained participants, Training Condition $F(2, 213) = 6.1$, $p < .01$. No other significant SC baseline differences were found.

Self-report of emotion. Outliers, skewness and kurtosis were examined using SPSS 18.0 Descriptives, Frequencies, and histograms (SPSS inc., Chicago, IL) on measures of valence, arousal, and trauma symptoms ten minutes post-writing (DTS-Short) for each of the three writing sessions were analyzed. No significant outliers were detected on any of these measures and kurtosis was within acceptable limits considering the sample size (Tabachnick & Fidell, 2001).

Table 2.

Baseline Heart Rate and Skin Conductance for Sessions One and Three

	Session 1			Session 3		
	Trauma	Neutral	Total	Trauma	Neutral	Total
Heart Rate (BPM)						
Response	81.7 (11.5)	77.4 (11.8)	79.7 (11.8)	81.6 (12.1)	78.9 (11.2)	80.4 (11.7)
Stimulus	76.0 (11.2)	79.2 (13.9)	77.9 (12.9)	80.6 (12.7)	81.2 (13.5)	81.0 (13.1)
No Training	75.2 (10.0)	78.5 (13.6)	76.9 (12.0)	82.0 (11.9)	81.4 (12.8)	81.7 (12.3)
Total	77.7 (11.2)	78.4 (13.2)	78.1 (12.3)	81.5 (12.1)	80.6 (12.6)	81.0 (12.4)
Skin Conductance (μmho)						
Response	.285 (.520)	.361 (.466)	.321 (.493)	.243 (.479)	.296 (.396)	.268 (.439)
Stimulus	.038 (.441)	.144 (.524)	.103 (.493)	.079 (.472)	.098 (.470)	.091 (.467)
No Training	.306 (.493)	.348 (.433)	.328 (.460)	.236 (.397)	.295 (.405)	.267 (.400)
Total	.218 (.498)	.271 (.486)	.247 (.491)	.191 (.451)	.217 (.437)	.206 (.443)

*Values in parentheses indicate standard deviations

Writing Condition x Training Condition x Session (1,2, and 3) analyses were run on the pre-writing data to examine whether there were significant baseline differences between participants randomized to the trauma and neutral writing groups and to the response, stimulus, and no training groups for valence or arousal in any of the three sessions (see Table 3). A comparison of baseline valence scores found that neutral writers [M = 6.6, SD = 1.8] reported lower levels of pleasantness than trauma writers [M = 7.0, SD = 1.7], Writing

Condition $F(1, 227) = 3.69$, $p = .05$. Further, participants reported that pleasantness decreased across sessions, Session $F(2, 226) = 4.23$, $p = .01$. Similarly, participants reported higher levels of arousal at baseline in sessions two and three than at baseline session one, Session $F(2, 226) = 5.95$, $p < .01$. No other significant baseline differences for valence or arousal were found ($p > .05$).

Table 3.

SAM Valence and Arousal Baseline Scores for each Writing Session

	Session 1			Session 2			Session 3		
	Trauma	Neutral	Total	Trauma	Neutral	Total	Trauma	Neutral	Total
Valence (Pre)									
Response	7.22 (1.36)	6.70 (1.35)	6.96 (1.37)	7.11 (1.74)	7.03 (1.44)	7.07 (1.59)	6.68 (2.20)	6.54 (1.64)	6.61 (1.92)
Stimulus	7.12 (1.41)	6.74 (1.67)	6.90 (1.57)	7.03 (1.78)	6.62 (1.66)	6.79 (1.71)	6.97 (1.31)	6.30 (1.76)	6.58 (1.61)
No Training	7.43 (1.24)	6.93 (1.58)	7.16 (1.44)	6.62 (1.53)	6.79 (1.41)	6.71 (1.46)	6.89 (1.91)	6.57 (1.86)	6.72 (1.88)
Total	7.26 (1.33)	6.79 (1.55)	7.01 (1.47)	6.92 (1.68)	6.79 (1.51)	6.85 (1.59)	6.84 (1.85)	6.46 (1.75)	6.64 (1.80)
Arousal (Pre)									
Response	4.08 (1.74)	4.08 (1.71)	4.08 (1.71)	4.54 (2.10)	4.05 (1.82)	4.30 (1.97)	4.05 (2.20)	4.57 (1.74)	4.31 (1.99)
Stimulus	3.70 (1.69)	3.77 (1.60)	3.74 (1.63)	3.91 (1.93)	4.23 (1.78)	4.10 (1.84)	3.76 (2.08)	4.53 (1.80)	4.21 (1.95)
No Training	3.59 (1.76)	4.07 (1.76)	3.85 (1.76)	4.35 (2.20)	4.45 (1.76)	4.41 (1.96)	4.32 (2.06)	4.60 (1.89)	4.47 (1.96)
Total	3.79 (1.73)	3.96 (1.68)	3.88 (1.70)	4.28 (2.08)	4.25 (1.78)	4.27 (1.92)	4.06 (2.10)	4.56 (1.80)	4.33 (1.96)

*Values in Parentheses indicate standard deviations

One month follow-up data. Outliers, skewness and kurtosis were examined using SPSS 18.0 Descriptives, Frequencies, and histograms (SPSS inc., Chicago, IL) on measures of physical illness (PILL), depression (CES-D), and trauma symptoms (DTS). For each measure at baseline and follow-up, no significant outliers were detected and kurtosis was within acceptable limits considering the sample size (Tabachnick & Fidell, 2001).

Between subjects (Writing Condition x Training Condition) analyses were run to examine whether there were significant baseline differences between participants randomized to the trauma and neutral writing groups and to the response, stimulus and no training groups on measures of trauma (DTS), depression (CES-D) and physical illness symptoms (PILL) (see Table 4). No significant baseline difference was found for frequency of common physical symptoms and sensations (physical illness symptoms), $p > .05$. Participants randomized to the neutral writing condition had higher depression symptom scores at baseline compared with those in the trauma writing condition, Writing Condition $F(1, 236) = 7.97$, $p < .05$. On the DTS subscale of severity of trauma symptoms, response-trained participants had higher severity scores at baseline than those randomized to the stimulus condition, and this finding was marginally significant, Training Condition $F(2,235) = 3.13$, $p = .05$. No significant difference was found at baseline on the DTS frequency subscale ($p>.05$).

Data Analysis

All follow-up analyses examining differences among the three sessions and/or the three training groups were conducted using the Simes correction of the Bonferroni correction (Simes, 1986).

Table 4.

Baseline and Follow up Data for DTS, CES-D, and PILL

	Trauma		Neutral		Total	
	Baseline	Follow up	Baseline	Follow up	Baseline	Follow up
DTS-Severity						
Response	19.3	11.2	23.3	10.7	21.4	10.9
	(18.16)	(13.01)	(15.70)	(13.15)	(16.90)	(12.97)
Stimulus	14.3	8.2	18.1	9.4	16.4	8.9
	(10.71)	(14.31)	(13.79)	(11.73)	(12.61)	(12.80)
No Training	19.6	12.2	18.6	11.3	19.1	11.8
	(13.38)	(11.29)	(14.03)	(12.46)	(13.58)	(11.77)
Total	17.9	10.7	19.8	10.4	18.9	10.5
	(14.38)	(12.79)	(14.51)	(12.30)	(14.44)	(12.50)
DTS-Frequency						
Response	16.8	11.3	22.3	11.8	19.6	11.6
	(15.19)	(12.65)	(13.34)	(11.35)	(14.44)	(11.92)
Stimulus	14.4	8.6	18.1	10.4	16.5	9.6
	(9.52)	(13.09)	(13.83)	(12.42)	(12.17)	(12.65)
No Training	18.3	12.7	18.7	9.9	18.5	11.3
	(11.59)	(10.29)	(13.16)	(11.49)	(12.27)	(10.89)
Total	16.6	10.9	19.6	10.7	18.1	10.8
	(12.30)	(11.99)	(13.46)	(11.72)	(12.96)	(11.82)
CES-D						
Response	14.37	14.40	17.28	16.79	15.83	15.60
	(9.14)	(7.52)	(11.16)	(11.98)	(10.15)	(9.75)
Stimulus	11.40	11.00	18.03	16.24	14.72	13.62
	(7.15)	(9.80)	(11.39)	(11.12)	(9.27)	(10.46)
No Training	12.58	14.52	14.29	12.84	13.44	13.68
	(6.40)	(6.86)	(8.73)	(8.59)	(7.57)	(7.73)
Total	12.78	13.31	16.53	15.29	14.66	14.30
	(7.56)	(8.06)	(10.43)	(10.56)	(9.00)	(9.31)
PILL						
Response	57.6	54.6	65.8	58.0	61.7	56.3
	(26.86)	(27.55)	(24.70)	(25.98)	(25.91)	(26.61)
Stimulus	54.2	45.7	55.6	51.6	55.0	49.1
	(23.03)	(21.38)	(27.25)	(24.76)	(25.34)	(23.38)
No Training	56.0	52.0	50.9	45.0	53.5	48.5
	(26.48)	(24.86)	(23.98)	(21.02)	(25.18)	(23.10)
Total	56.0	51.0	57.3	51.6	56.7	51.3
	(25.34)	(24.82)	(25.93)	(24.37)	(25.59)	(24.52)

*Values in Parentheses indicate standard deviations

Physiological data. A goal of the present study was to determine if participants who received response training and engaged in trauma writing would show greater initial physiological reactivity (HR and SC) in session one than neutral writing and greater habituation from session one to session three than neutral writing. To test hypotheses 1, 2 and 3, a regression model with correlated error structure analysis was conducted, using the mean of baseline session one as covariate for session 1 and the mean of baseline session three as covariate for session 3 to control for baseline levels. The independent variables included were writing condition (trauma, neutral), training condition (response, stimulus, no training), session (session one, session three), and period nested within session (minutes 3-8; minutes 9-14; and minutes 15-20). The dependent variables included were six difference scores (three difference scores from session one and three difference scores from session three).

Heart rate. HR difference scores are shown in Table 5 and the HR regression results are shown in Table 6. Participants' HR decreased linearly across the three periods, Period $F(2, 224.7) = 2.68$, $p = .07$, with a significant linear component. In session one, no significant difference across time periods was found, whereas in session three, HR decreased significantly across the three periods, Period x Session $F(2, 224.7) = 8.15$, $p < .001$.

Table 5.

Heart Rate Difference Scores (beats/min): Writing Condition by Training Condition by Session by Period

	Session 1				Session 3			
	Min 3-8	Min 9-14	Min 15-20	Total	Min 3-8	Min 9-14	Min 15-20	Total
Trauma Writers								
Response	5.559 (12.394)	5.537 (12.208)	5.824 (13.199)	5.640 (12.600)	5.018 (11.836)	3.923 (13.153)	4.935 (13.880)	4.625 (12.956)
Stimulus	3.384 (13.493)	3.821 (13.292)	4.282 (14.361)	3.829 (13.715)	3.950 (12.936)	4.335 (14.377)	3.650 (15.182)	3.978 (14.165)
No Training	2.947 (12.936)	3.318 (12.750)	2.634 (13.772)	2.966 (13.153)	3.627 (11.929)	3.078 (13.246)	1.830 (13.974)	2.845 (13.050)
Total	3.963 (12.941)	4.225 (12.750)	4.247 (13.777)	4.145 (13.156)	4.198 (12.234)	3.779 (13.592)	3.472 (14.345)	3.816 (13.390)
Neutral Writers								
Response	4.025 (13.400)	3.925 (13.199)	4.115 (14.284)	4.022 (13.628)	5.138 (12.409)	5.281 (13.772)	4.549 (14.531)	4.990 (13.571)
Stimulus	3.042 (11.185)	3.070 (11.015)	3.139 (11.913)	3.084 (11.371)	4.984 (10.519)	4.789 (11.681)	4.025 (12.316)	4.599 (11.505)
No Training	3.515 (12.409)	3.585 (12.192)	4.089 (13.230)	3.730 (12.610)	3.543 (10.906)	2.458 (12.100)	1.521 (12.765)	2.507 (11.924)
Total	3.527 (12.331)	3.527 (12.135)	3.781 (13.142)	3.612 (12.536)	4.555 (11.278)	4.176 (12.518)	3.365 (13.204)	4.032 (12.333)

*Values in parentheses indicate Standard Deviations

Table 6.

Regression model with correlated error structure for HR controlling for the means of HR baseline sessions One and Three

Source	*df*	*F*	*P*
Writing Condition (W)	1, 228.9	.087	.768
Training Condition (T)	2, 229.0	3.733	.025†
W * T	2, 229.5	.207	.813
Period (P)	2, 224.7	2.680	.071‡
Session (S)	1, 226.3	.017	.898
P * S	2, 224.7	8.145	.000†
W * P	2, 224.7	.342	.711
W * S	1, 219.1	1.131	.289
T * P	4, 224.7	2.454	.047†
T * S	2, 219.7	1.569	.211
W * T * P	4, 224.7	2.251	.065‡
W * T * S	2, 219.0	1.799	.168
W * P * S	2, 224.7	.971	.380
T * P * S	4, 224.7	1.453	.217
W * T * P * S	4, 224.7	.954	.434
HR_M_B	1, 400.0	28.244	.000†

†Indicates $p < .05$
‡Indicates $p < .10$

Hypothesis 1 was that trauma writing would increase HR more than neutral writing, i.e., a Writing Condition effect. Although trauma writing produced a slightly greater HR increase than neutral writing in the middle [trauma M = 4.0, SD = 6.3 versus neutral M = 3.8, SD = 5.9] and end [trauma M = 3.9, SD = 6.6 versus neutral M = 3.6, SD = 6.2] of the writing period, this was not significant, Writing Condition $F(1, 228.9) = .09$, $p = 0.77$.

Response-trained participants had greater HR reactivity than no training participants (p = .01), with stimulus participants between the two and not significantly different from either (stimulus training versus response training p = .16; stimulus training versus no training p = .19), Training Condition $F(2, 229.0) = 3.73$, p = .03. As can be seen in Figure 2, HR was maintained throughout the 20 minutes of writing for response and stimulus-trained participants, but for no training participants HR decreased across periods, with minutes 15-20 producing significantly lower HR than minutes 3-8 and 9-14, Training Condition x Period , $F(4, 224.7) = 2.45$, p = .04. These training condition effects were apparent across both trauma and neutral writing.

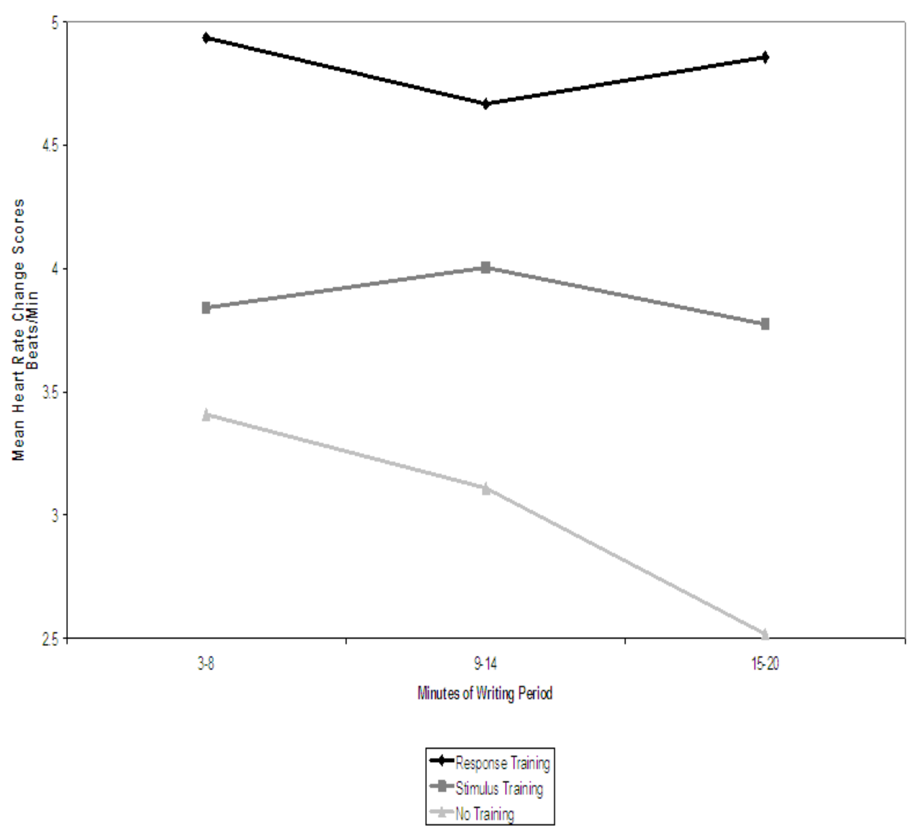
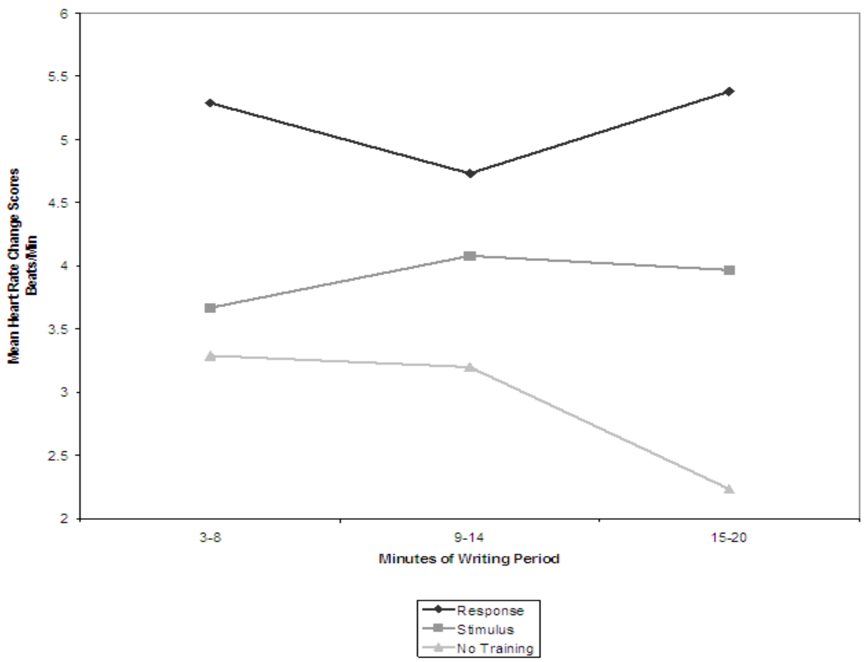


Figure 2. Heart Rate Reactivity in Minutes 3-8, 9-14 and 15-20 of Writing in Session One by Training Condition.

Hypothesis 2 was that response training would increase HR to trauma writing more than stimulus or no training, whereas no training condition differences were expected as a result of neutral writing. There was some indication that response training effected HR among trauma writers more than neutral writers. Response-trained trauma writers had marginally significantly greater HR reactivity at minutes 3-8 ($p = .03$), and significantly greater HR reactivity at minutes 15-20 ($p < .01$) than no training participants. As can be seen in Figure 3, among neutral writers, no significant differences among training conditions were found. This pattern resulted in a Writing Condition x Training Condition x Period interaction $F(4, 224.7) = 2.25$, $p = .06$.

Hypothesis 3 was that response training would lead to greater habituation to trauma writing, as evidenced by greater reductions in HR reactivity, than stimulus or no training from session one to session three, whereas no differences in habituation were expected among training conditions as a result of neutral writing i.e., a Writing Condition x Training Condition x Session. As shown in Figure 4, this pattern of results was found, but not significant, $F(2, 219.0) = 1.79$, $p < .17$. Response trained trauma writers showed greater HR than no training participants in session one ($p = .02$), but this difference was not significant by session three ($p = .11$). Stimulus-trained trauma writers HR fell between response-trained and no training trauma writers in sessions one and three, but was not significantly different than either training condition in session one (response training versus stimulus training $p = .12$; response training versus no training $p = .46$) or in session three (response training versus stimulus training $p = .58$; response training versus no training $p = .33$).

Training Condition x Period Interaction, Trauma Writers



Training Condition x Period Interaction, Neutral Writers

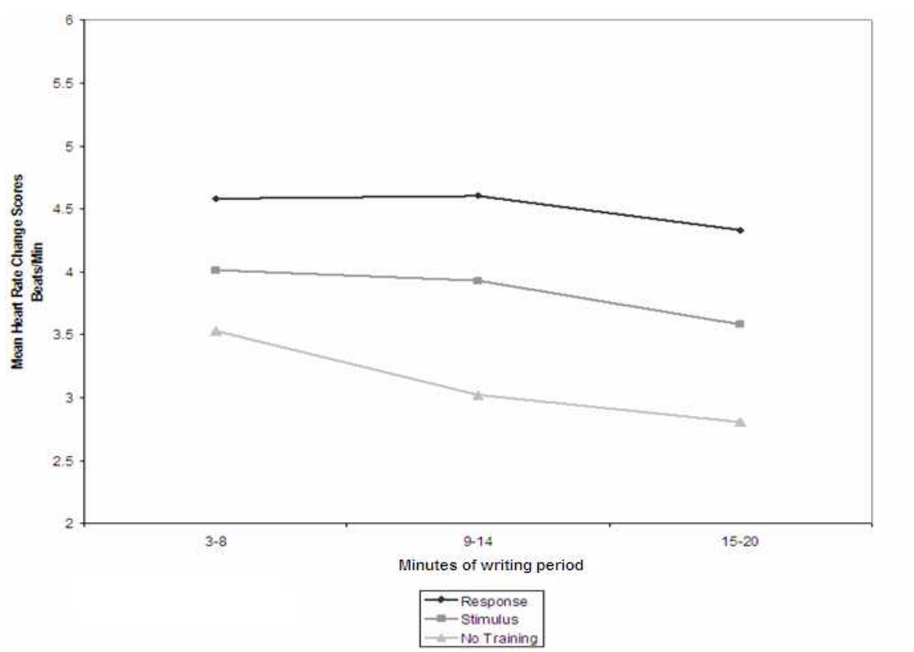
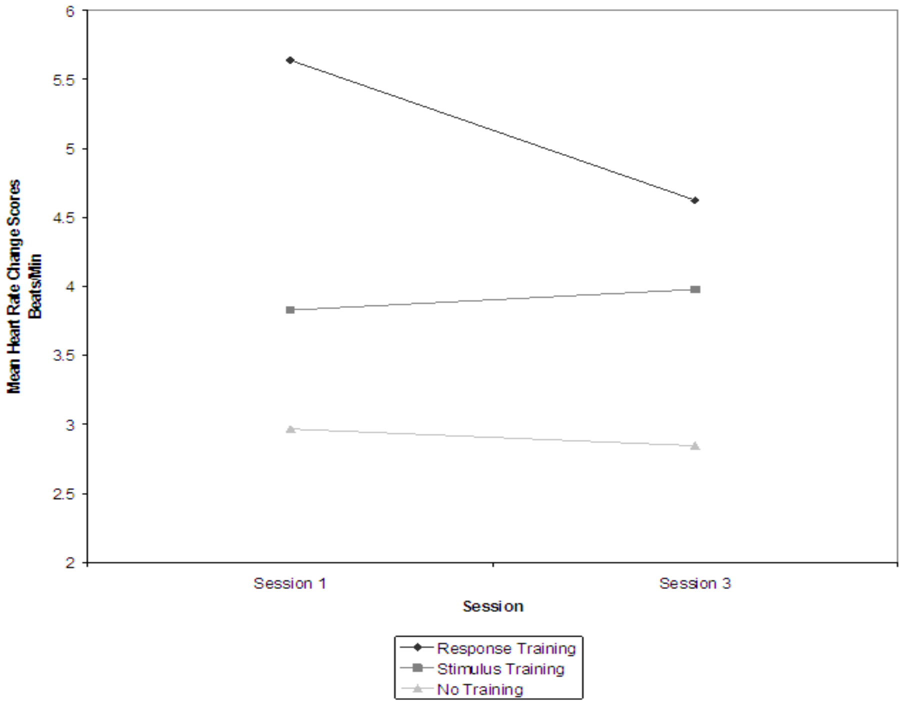


Figure 3. Heart Rate Reactivity in Minutes 3-8, 9-14, 15-20 of Writing in Session One by Writing Condition and Training Condition.

Training Condition x Session Interaction, Trauma Writers



Training Condition x Session Interaction, Neutral Writers

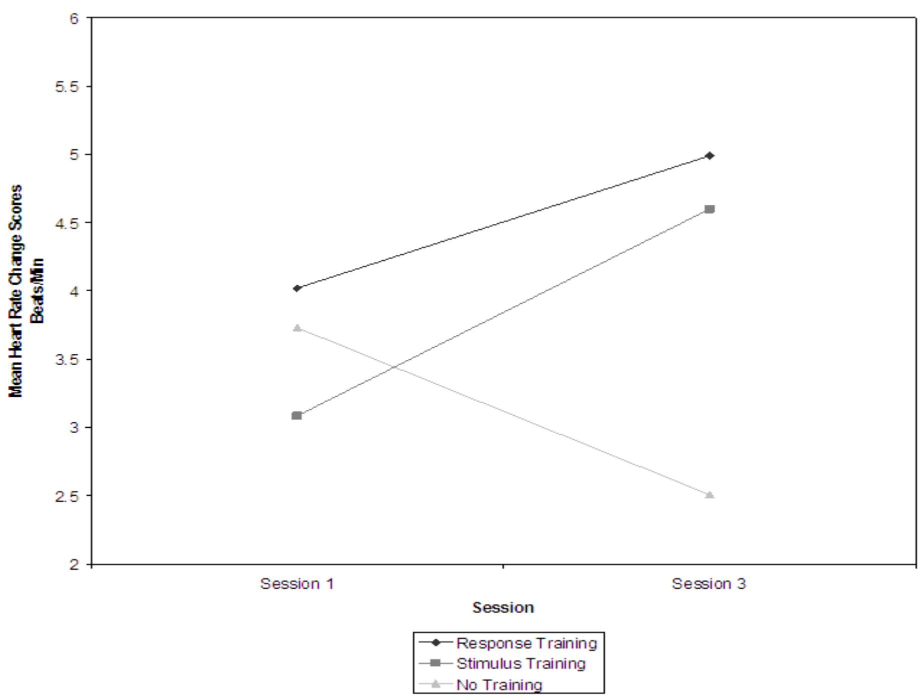


Figure 4. Heart Rate Reactivity in Sessions One and Three by Writing Condition and Training Condition.

For neutral writers, no differences in HR were found among training conditions in session one, however, in session three response-trained neutral writers showed greater HR than no training participants (p = .02).

Skin conductance. SC difference scores are shown in Table 7 and SC regression results are shown in Table 8. SC reactivity decreased from sessions one to three, Session $F(1, 228.1) = 26.20$, $p < .001$. Participants' SC increased across the three periods within session, Period $F(2, 236.0) = 48.82$, $p < .001$. However, as can be seen in Figure 5, among no training participants, SC did not increase significantly between minutes 3-8 and 9-14, but did increase significantly between minutes 3-8 and 15-20 and between minutes 9-14 and 15-20, Training Condition x Period interaction, $F(4, 235.9) = 2.64$, $p = .03$.

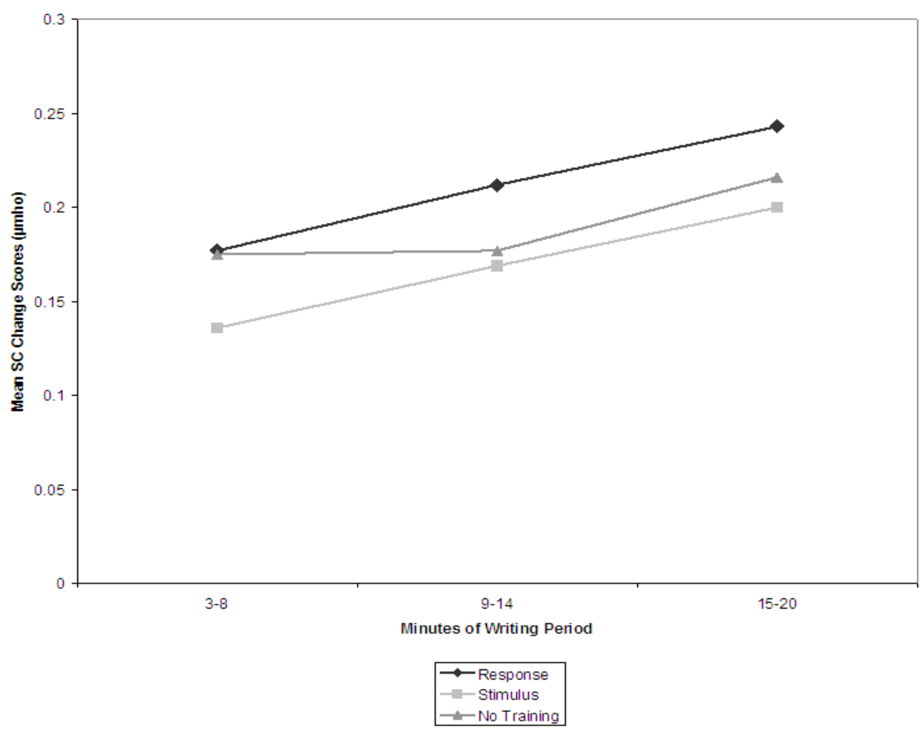


Figure 5. Skin Conductance Reactivity in Minutes 3-8, 9-14 and 15-20 of Writing in Session One by Training Condition.

Table 7.

Skin Conductivity Difference Scores: Writing Condition by Training Condition by Session by Period

	Session 1				Session 3			
	Min 3-8	Min 9-14	Min15-20	Total	Min 3-8	Min 9-14	Min 15-20	Total
Trauma Writers								
Response	.252 (.594)	.280 (.609)	.307 (.656)	.280 (.620)	.139 (.562)	.193 (.609)	.226 (.625)	.186 (.599)
Stimulus	.230 (.656)	.267 (.672)	.306 (.719)	.268 (.682)	.089 (.609)	.157 (.656)	.190 (.672)	.145 (.646)
No Training	.215 (.625)	.195 (.640)	.232 (.687)	.214 (.651)	.140 (.547)	.132 (.594)	.168 (.609)	.147 (.583)
Total	.232 (.625)	.247 (.640)	.282 (.687)	.254 (.651)	.123 (.573)	.161 (.620)	.195 (.635)	.159 (.609)
Neutral Writers								
Response	.189 (.625)	.229 (.640)	.248 (.687)	.222 (.651)	.128 (.578)	.147 (.625)	.192 (.640)	.156 (.614)
Stimulus	.155 (.547)	.158 (.547)	.186 (.594)	.166 (.563)	.069 (.484)	.094 (.531)	.117 (.547)	.093 (.521)
No Training	.222 (.578)	.234 (.594)	.266 (.625)	.241 (.599)	.125 (.515)	.148 (.562)	.196 (.578)	.156 (.552)
Total	.189 (.583)	.207 (.594)	.233 (.635)	.210 (.604)	.107 (.526)	.130 (.573)	.168 (.588)	.135 (.562)

*Values in parentheses indicate Standard Deviations

Hypothesis 1 was that trauma writing would increase SC more than neutral writing. Trauma writing [M = .207 micromhos, SD = 0.281 micromhos] increased SC more than neutral writing [M = .172 micromhos, SD = 0.297 micromhos], however, this pattern was not significant, Writing Condition $F(1, 238.3) = 1.73$, $p = .19$.

Table 8.

Regression model with correlated error structure for SC controlling for the means of SC baseline sessions One and Three

Source	*df*	*F*	*p*
Writing Condition (W)	1, 238.3	1.734	.189
Training Condition (T)	2, 240.8	.862	.424
W * T	2, 237.5	1.173	.311
Period (P)	2, 236.0	48.815	.000†
Session (S)	1, 228.1	26.195	.000†
P * S	2, 234.8	1.988	.139
W * P	2, 236.0	.293	.746
W * S	1, 227.3	.363	.547
T * P	4, 235.9	2.643	.034†
T * S	2, 227.2	.165	.848
W * T * P	4, 235.9	2.685	.032†
W * T * S	2, 227.2	.360	.698
W * P * S	2, 234.8	.734	.481
T * P * S	4, 234.7	.484	.748
W * T * P * S	4, 234.7	.362	.835
log_SC_M_B	1, 430.0	42.672	.000†

†Indicates $p < .05$

Hypothesis 2 was that response training would increase SC reactivity to trauma writing more than stimulus or no training, whereas no training condition differences were expected as a result of neutral writing, i.e. Writing Condition x Training Condition x Period interaction. This interaction was significant, but the specific pattern found was contrary to expectations. Stimulus-trained trauma writing participants had greater SC at minutes 15-20 ($p = .05$) than stimulus-trained neutral writing participants, $F(4, 235.9) = 2.69$, $p = .03$ (see Table 7). No other significant differences among writing or training conditions were found.

Hypothesis 3 was that response training would lead to greater habituation to trauma writing, as evidenced by greater reductions in SC, than stimulus or no training from sessions one to three, whereas no differences in habituation were expected among training conditions as a result of neutral writing i.e., a Writing Condition x Training Condition x Session. Contrary to expectations this was not found, $F(2, 227.2) = 0.36$, $p = .70$.

Effects of writing on trauma symptoms within sessions. A goal of the present study was to determine if participants who received response training and engaged in trauma writing would show greater habituation as evidenced by greater reductions in trauma symptom severity and frequency across writing sessions. To test Hypotheses 4, 5, and 6, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) x 3 Session (session one, session two, session three) repeated measures ANOVA was conducted. The dependent variables were DTS-short trauma symptom severity and frequency scores, which were obtained ten minutes post-writing in each session. DTS-short post-traumatic symptom severity and frequency means are presented in Table 9 and ANOVA results are presented in Table 10.

Hypothesis 4 was that trauma writing would increase reported DTS-short trauma symptom severity and frequency more than neutral writing. As expected, trauma writing increased reported levels of trauma symptom severity [M = 10.5, SD = 10.54] and frequency [M = 11.3, SD = 9.94] more than neutral writing [M = 3.8, SD = 6.47; M = 4.4, SD = 6.51], respectively, Writing Condition severity, $F(1, 214) = 41.08$, $p < .001$, frequency, $F(1, 218) = 47.45$, $p < .001$.

Table 9.

DTS-Short Trauma Symptoms Severity and Frequency Means for all Sessions

	Session 1		Session 2		Session 3		Total	
	DTS-Short Severity	DTS-Short Frequency	DTS-Short Severity	DTS-Short Frequency	DTS-Short Severity	DTS-Short Frequency	DTS-Short Severity	DTS-Short Frequency
Trauma Writers								
Response	12.7 (11.18)	14.1 (11.16)	9.2 (9.60)	10.6 (9.14)	7.9 (10.39)	9.0 (10.73)	9.9 (10.39)	11.3 (10.34)
Stimulus	12.1 (10.40)	12.6 (9.78)	8.5 (9.78)	9.0 (8.84)	7.0 (9.81)	7.2 (8.45)	9.2 (9.99)	9.6 (9.2)
No Training	15.3 (11.48)	15.5 (10.09)	12.3 (10.60)	13.2 (10.42)	9.7 (11.59)	10.5 (10.32)	12.4 (11.22)	13.1 (10.28)
Total	13.4 (11.02)	14.1 (10.35)	10.0 (10.03)	11.0 (9.56)	8.2 (10.58)	8.9 (9.92)	10.5 (10.54)	11.3 (9.94)
Neutral Writers								
Response	3.3 (5.85)	4.4 (6.47)	4.0 (7.16)	4.4 (6.45)	5.1 (6.34)	5.3 (6.70)	4.1 (6.45)	4.7 (6.54)
Stimulus	3.1 (5.10)	3.8 (5.13)	4.0 (7.42)	4.2 (6.88)	3.5 (7.05)	4.3 (7.19)	3.5 (6.53)	4.1 (6.40)
No Training	5.1 (7.63)	5.7 (7.68)	3.5 (6.04)	4.3 (6.06)	2.9 (5.12)	3.4 (5.88)	3.8 (6.26)	4.5 (6.54)
Total	3.9 (6.30)	4.6 (6.48)	3.8 (6.85)	4.3 (6.43)	3.7 (6.25)	4.3 (6.61)	3.8 (6.47)	4.4 (6.51)

*Values in Parentheses indicate standard deviations

Hypothesis 5 was that, among trauma writers, response training would lead to greater reported DTS-short trauma symptom severity and frequency than stimulus or no training, whereas no training condition differences were expected as a result of neutral writing i.e., a Writing Condition x Training Condition interaction. Contrary to expectations, this pattern was not found for severity, $F(2, 214) = .82$, $p > .05$, or frequency, $F(2, 218) = 0.86$, $p > .05$.

Table 10.

Analysis of Variance for DTS-Short Frequency and Severity

	Frequency			Severity		
Source	*df*	*F*	*p*	*df*	*F*	*p*
Time	2, 217	15.198	.0001†	2, 213	13.456	.0001†
Time * Writing Condition (W)	2, 217	12.421	.0001†	2, 213	13.140	.0001†
Time * Training Condition (T)	4, 436	.924	.450	4, 428	1.320	.262
Time * W * T	4, 436	.685	.602	4, 428	.732	.570
W	1, 218	47.454	.0001†	1, 214	41.080	.0001†

†Indicates $p < .05$

As can be seen in Figure 6, participants reported habituation of trauma symptom severity and frequency across sessions, Session $F(2, 213) = 13.46$, $p < .001$, $F(2, 217) = 15.20$, $p < .001$, with trauma writing, but not neutral writing leading to habituation, Writing Condition x Session, severity, $F(2, 213) = 13.14$, $p < .001$, and frequency, $F(2, 217) = 12.42$, $p < .001$.

Hypothesis 6 was that response training would lead to greater habituation to trauma writing, as evidenced by greater reductions in reported DTS-short trauma symptom severity and frequency, than stimulus or no training from sessions one to three, whereas no differences in habituation were expected among training conditions as a result of neutral writing i.e., a Writing Condition x Training Condition x Session interaction. Contrary to expectations, this pattern was not found, severity, $F(2, 214) = 1.18$, $p < .40$, and frequency, $F(2, 218) = 1.29$, $p < .30$.

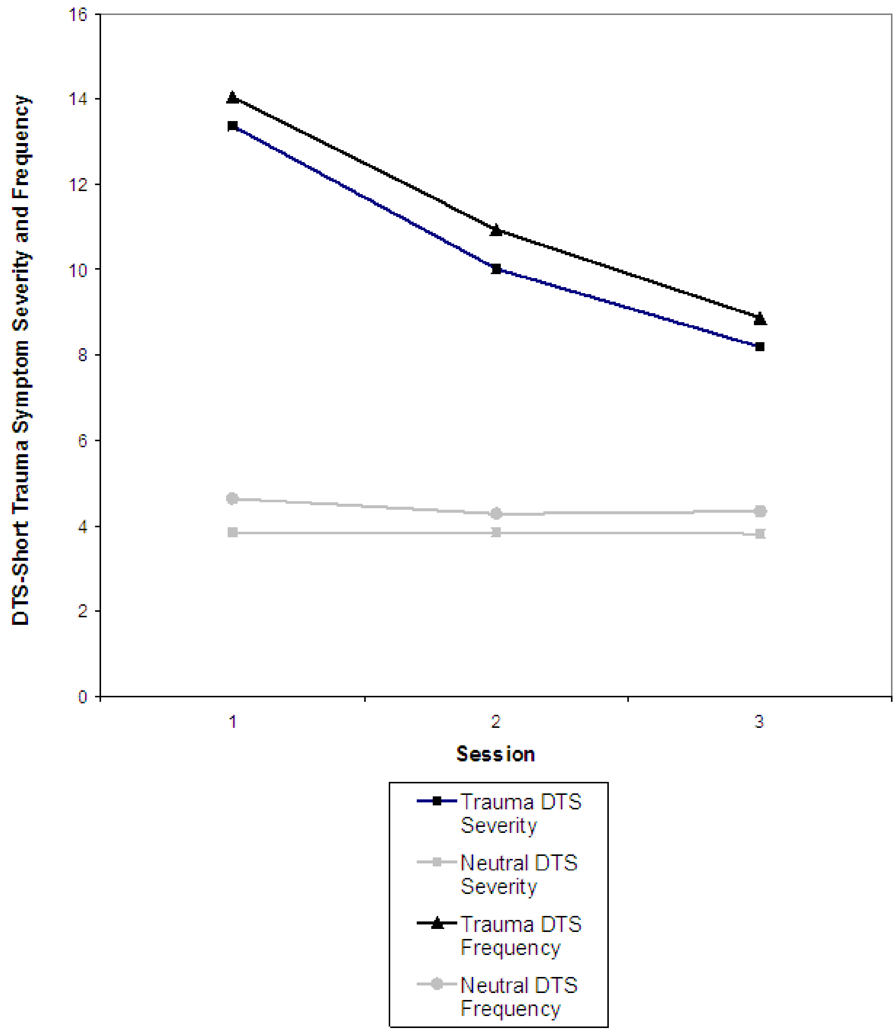


Figure 6. DTS-short Severity and Frequency of Trauma Symptoms Ten Minutes Post Writing in Each Session by Writing Condition.

Levels of pleasantness and arousal. A goal of the present study was to determine if participants who received response training and engaged in trauma writing would report lower levels of pleasantness (negative valence) and greater arousal than neutral writing, and greater habituation from sessions one to three than neutral writing. To test hypotheses 7, 8 and 9, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) x 3 Session (session one, session two, session three) x 2 Prepost (pre-writing, post-writing) repeated measures ANOVA was conducted. The dependent variables were SAM pleasantness (valence) and arousal scores which were obtained before and immediately after writing in each session. SAM pleasantness (valence) and arousal means are presented in Table 11 and Table 12, respectively. ANOVA results are presented in Table 13.

Levels of pleasantness. Hypothesis 7 was that trauma writing would decrease reported levels of pleasantness on the SAM more than neutral writing, i.e., a Writing Condition x Prepost interaction. As expected, this was only the case for trauma writing, and neutral writing did not change levels of pleasantness, Writing Condition x Prepost, $F(1,227) = 84.11$, $p < .001$. Main effects of Writing Condition and Prepost were also found. Trauma writing [$M = 6.3$, SD = 1.7] decreased levels of pleasantness (negative valence) more than neutral writing [$M = 6.7$, SD = 1.8], Writing Condition, $F(1, 227) = 4.30$, $p = .04$. Participants' reported lower levels of pleasantness (negative valence) after writing [$M = 6.2$, SD = 1.4] compared to before writing [$M = 6.9$, SD = 1.3], Prepost $F(1, 227) = 87.94$, $p < .001$.

Hypothesis 8 was that among trauma writers, response training would lead to a greater decrease in reported SAM levels of pleasantness (negative valence) than stimulus or no training, whereas no training differences were expected as a result of neutral writing, i.e., a Writing Condition x Training Condition x Prepost interaction. Contrary to expectations, this pattern was not found, $F(2, 227) = .52$, $p = .59$.

Table 11.

SAM Valence Means for all sessions before and after writing

	Session 1		Session 2		Session 3		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Trauma Writers								
Response	7.2 (1.36)	5.5 (2.06)	7.1 (1.74)	5.6 (1.95)	6.7 (2.20)	6.1 (1.97)	7.0 (1.76)	5.7 (1.99)
Stimulus	7.1 (1.42)	5.5 (2.03)	7.0 (1.78)	5.7 (1.81)	7.0 (1.31)	6.2 (1.56)	7.0 (1.50)	5.8 (1.80)
No Training	7.4 (1.24)	5.3 (2.24)	6.6 (1.53)	5.4 (1.77)	6.9 (1.91)	6.0 (2.07)	7.0 (1.56)	5.6 (2.03)
Total	7.3 (1.33)	5.4 (2.10)	6.9 (1.68)	5.5 (1.83)	6.8 (1.85)	6.1 (1.88)	7.0 (1.62)	5.7 (1.94)
Neutral Writers								
Response	6.7 (1.35)	6.3 (1.54)	7.0 (1.44)	6.7 (1.59)	6.5 (1.64)	6.6 (1.36)	6.7 (1.48)	6.5 (1.50)
Stimulus	6.7 (1.67)	6.9 (1.35)	6.6 (1.66)	6.5 (1.86)	6.3 (1.76)	6.7 (1.55)	6.5 (1.70)	6.7 (1.59)
No Training	6.9 (1.58)	6.9 (1.37)	6.8 (1.41)	6.8 (1.31)	6.6 (1.86)	6.6 (1.74)	6.8 (1.62)	6.8 (1.47)
Total	6.8 (1.55)	6.7 (1.43)	6.8 (1.51)	6.7 (1.61)	6.5 (1.75)	6.6 (1.55)	6.7 (1.60)	6.7 (1.53)

*Values in Parentheses indicate standard deviations

Table 12.

SAM Arousal Means for all sessions before and after writing

	Session 1		Session 2		Session 3		Total	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Trauma Writers								
Response	4.1 (1.71)	4.5 (2.10)	4.5 (2.10)	4.5 (1.99)	4.1 (2.20)	3.6 (2.20)	4.2 (2.00)	4.2 (2.10)
Stimulus	3.7 (1.69)	4.5 (1.97)	3.9 (1.93)	4.5 (1.75)	3.8 (2.08)	3.5 (1.87)	3.8 (1.90)	4.2 (1.86)
No Training	3.6 (1.76)	4.3 (2.01)	4.4 (2.20)	4.5 (2.13)	4.3 (2.06)	4.4 (2.10)	4.1 (2.01)	4.4 (2.08)
Total	3.8 (1.73)	4.5 (2.02)	4.3 (2.08)	4.5 (1.95)	4.1 (2.10)	3.9 (2.09)	4.1 (1.97)	4.3 (2.02)
Neutral Writers								
Response	4.1 (1.71)	3.3 (1.93)	4.1 (1.82)	4.3 (1.76)	4.6 (1.74)	3.6 (1.65)	4.3 (1.76)	3.7 (1.78)
Stimulus	3.8 (1.60)	3.7 (1.99)	4.2 (1.78)	3.7 (1.68)	4.5 (1.80)	3.7 (1.72)	4.2 (1.73)	3.7 (1.80)
No Training	4.1 (1.76)	3.7 (1.67)	4.5 (1.76)	4.0 (1.83)	4.6 (1.89)	3.6 (1.94)	4.4 (1.80)	3.8 (1.81)
Total	4.0 (1.68)	3.6 (1.86)	4.3 (1.78)	4.0 (1.76)	4.6 (1.80)	3.7 (1.76)	4.3 (1.75)	3.8 (1.79)

*Values in Parentheses indicate standard deviations

Table 13.

Analysis of Variance for Valence and Arousal

	Valence			Arousal		
Source	*df*	*F*	*p*	*df*	*F*	*p*
Session (s)	2, 226	.114	.892	2, 226	4.415	.013†
S * Writing Condition (W)	2, 226	2.538	.081‡	2, 226	2.900	.057‡
S * Training Condition (T)	4, 454	.855	.491	4, 454	.688	.600
S * W * T	4, 454	.845	.497	4, 454	1.249	.289
Prepost (P)	1, 227	87.938	.0001†	1, 227	2.488	.116
P * W	1, 227	84.112	.0001†	1, 227	21.282	.0001†
P * T	2, 227	.795	.453	2, 227	.472	.624
P * W * T	2, 227	.522	.594	2, 227	.641	.528
S * P	2, 226	18.784	.0001†	2, 226	8.007	.0001†
S * P * W	2, 226	6.463	.002†	2, 226	1.488	.228
S * P * T	4, 454	1.304	.267	4, 454	.918	.453
S * P * W * T	4, 452	.465	.762	4, 454	1.381	.239

†Indicates $p < .05$
‡Indicates $p < .10$

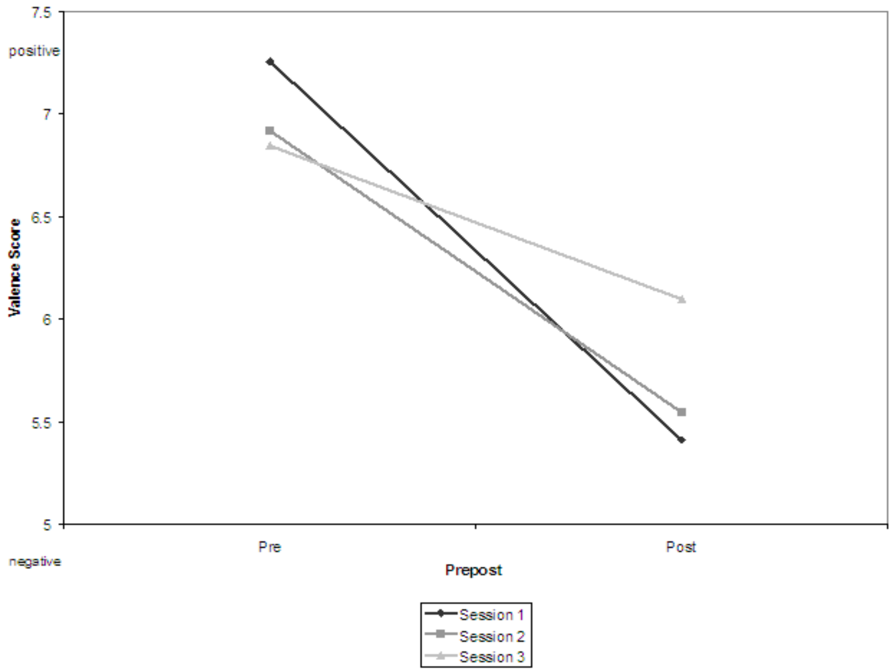
As can be seen in Figure 7, a significant Writing Condition x Prepost x Session interaction $F(2, 226) = 6.46$, $p < .01$ was found which was caused by a complex pattern of results. In Figure 7, lower valence scores reflect lower levels of pleasantness. Participants' levels of pleasantness decreased from before to after writing, overall Prepost $F(2, 226) = 18.78$, $p < .001$. However, this was only the case for trauma writers, $F(2, 103) = 18.05$, $p < .001$. Trauma writing produced anticipatory unpleasantness in session two and three, with significantly lower levels of pleasantness (negative valence) before writing in sessions two and three compared to before writing in session one. Trauma writing also led to significantly higher levels of pleasantness (positive valence) after writing in session three compared to after writing in sessions one and two, suggesting that across session habituation had occurred. The Session x Prepost interaction was not significant for neutral writers, $F(2, 122) = 2.58$, $p = .08$.

Hypothesis 9 was that response training would lead to greater habituation to trauma writing, as evidenced by greater increases in reported SAM levels of pleasantness than stimulus or no training from session one to session three, whereas no differences in habituation were expected among training conditions as a result of neutral writing, i.e., a Writing Condition x Training Condition x Prepost x Session interaction. Contrary to expectations, this pattern was not found, $F(2, 227) = .69$, $p = .50$.

Levels of arousal. Hypothesis 7 was that trauma writing would increase reported SAM levels of arousal more than neutral writing, i.e., a Writing Condition x Prepost interaction. As can be seen in Table 12 (Total cells column), trauma writing increased arousal levels, whereas neutral writing decreased arousal levels, Writing Condition x Prepost $F(1, 227) = 21.28$, $p < .001$.

Hypothesis 8 was that among trauma writers, response training would lead to a greater increase in reported arousal than stimulus or no training, whereas no training differences were expected as a result of neutral writing, i.e., a Writing Condition x Training Condition x Prepost interaction. Contrary to expectations, this pattern was not found, $F(2, 227) = .64$, $p = .53$.

Session x Prepost, Trauma Writers



Session x Prepost, Neutral Writers

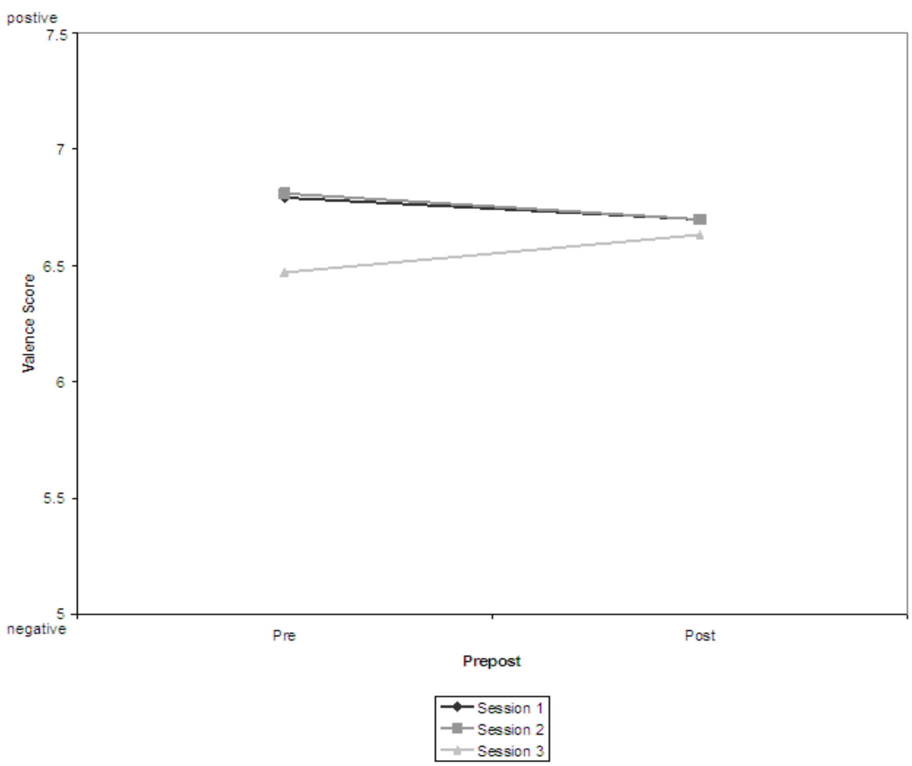
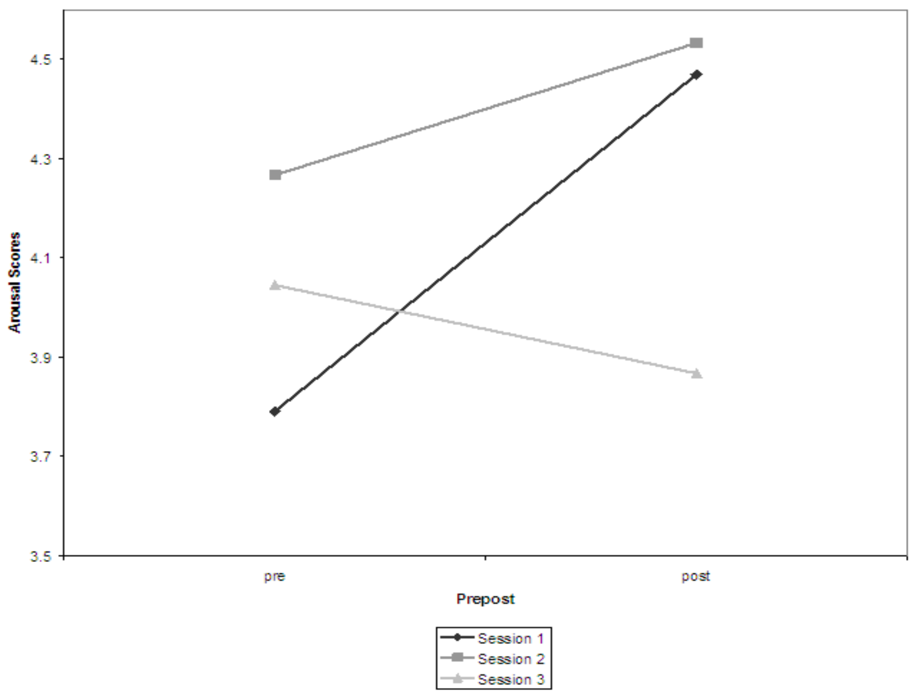


Figure 7. SAM Pleasantness Level Pre and Post Writing for Each Session by Writing Condition.

Participants' reported levels of arousal increased from before to after writing in session one did not significantly change in session two, and decreased in session three, Session x Prepost $F(2, 226) = 8.01$, $p < .001$. From session one to session two, participants' arousal levels increased, whereas from session two to session three, a decrease occurred, but this decrease was not significant, Session $F(2, 226) = 4.41$, $p = .01$. As can be seen in Figure 8, among trauma writers, arousal levels marginally increased from session one to session two ($p = .08$), and decreased significantly from session two to session three ($p = .01$), whereas among neutral writers arousal increased from session one to two ($p = .02$), and showed no significant change from session two to three ($p = .96$), Writing Condition x Session $F(2, 226) = 2.90$, $p = .05$. It is important to note that this significant interaction does not include changes in arousal levels from before to after writing, thus the reduction in arousal levels seen across-sessions among trauma writers was not due to writing within each session.

Hypothesis 9 was that response training would lead to greater habituation to trauma writing, as evidenced by greater across-session reductions in reported SAM levels of arousal, than stimulus or no training, whereas no differences in habituation were expected among training conditions as a result of neutral writing, i.e., a Writing Condition x Training Condition x Prepost x Session interaction. The pattern found provided partial support for the hypothesis, and the findings approached significance, $F(2, 227) = 2.61$, $p = .08$. The pattern found was that among response and stimulus-trained trauma writers arousal levels decreased from post session two to post session three (response training, $p = .009$ and stimulus training, $p = .006$), whereas among response-trained neutral writers arousal levels increased from post session one to post session two ($p = .005$).

Session x Prepost, Trauma Writers



Session x Prepost, Neutral Writers

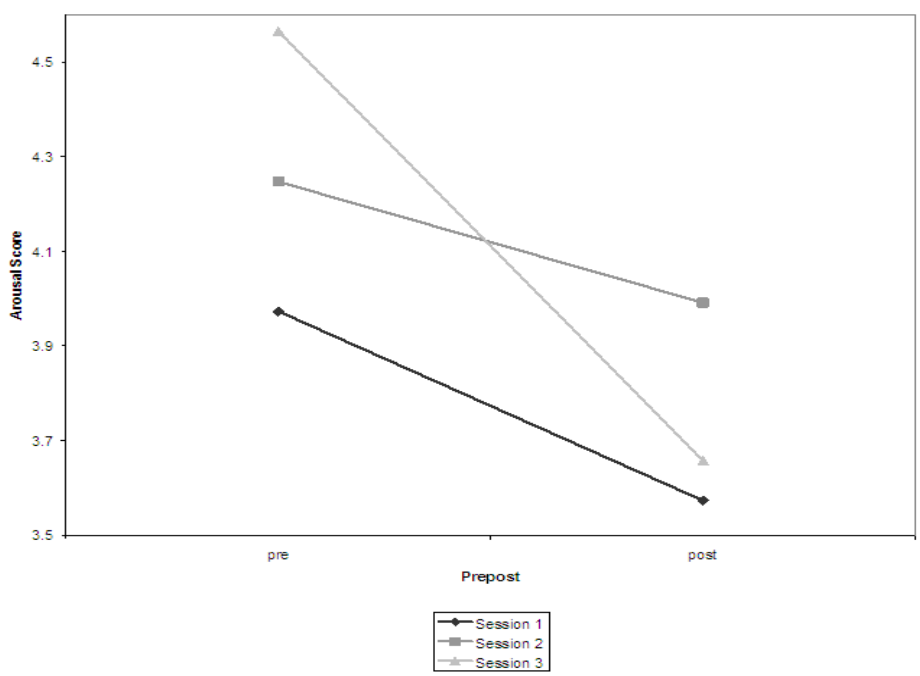


Figure 8. SAM Arousal Level Pre and Post Writing for Each Session by Writing Condition.

Health effects of writing at follow-up. A goal of the present study was to determine if participants who received response training and engaged in trauma writing would show greater improvements in psychological and physical health at follow-up. To test Hypotheses 10 and 11 for physical illness and trauma symptoms, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) x 2 Interval (baseline, one-month follow-up) repeated measures ANOVA was conducted. The dependent variables were PILL physical illness symptoms and DTS trauma symptom severity and frequency baseline and follow-up scores. Since depression scores were significantly different between writing groups at baseline, to test hypotheses 10 and 11 for depression symptoms, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) univariate analysis of covariance (ANCOVA) was conducted with baseline depression scores as the covariate. The dependent variable was CES-D depression scores at follow-up. Baseline and follow-up data for DTS, CES-D, and the PILL are presented in Table 4.

Trauma symptom severity (DTS). Hypothesis 10 was that trauma writing would reduce DTS severity of trauma symptoms more than neutral writing from baseline to the one month follow-up. Participants reported a decrease in severity of trauma symptoms from baseline to follow-up, Interval $F(1, 175) = 78.33$, $p < .001$. While both trauma and neutral writing led to a reduction in severity of trauma symptoms, trauma writing did not reduce severity of trauma symptoms more than neutral writing from baseline to follow-up, Writing Condition x Interval $F(1, 175) = 1.58$, $p = .21$.

Hypothesis 11 was that among trauma writers, response training would lead to a greater reduction in DTS severity of trauma symptoms than stimulus or no training, whereas no training differences were expected as a result of neutral writing, i.e., a Writing Condition x Training Condition x Interval interaction. Contrary to expectations, this pattern was not found, $F(2, 175) = .52$, $p = .59$.

Trauma symptom frequency (DTS). Hypothesis 10 was that trauma writing would reduce DTS frequency of trauma symptoms more than neutral writing from baseline to follow-up. Participants reported a decrease in frequency of trauma symptoms from baseline to the one month follow-up, Interval $F(1, 184) = 78.97$, $p < .001$. Contrary to what was predicted, neutral writing reduced trauma symptom frequency more than trauma writing, Writing Condition x Interval $F(1, 184) = 4.04$, $p = .05$.

Hypothesis 11 was that among trauma writers, response training would lead to a greater reduction in DTS frequency of trauma symptoms than stimulus or no training, whereas no training differences were expected as a result of neutral writing, i.e., a Writing Condition x Training Condition x Interval interaction. Contrary to expectations, this pattern was not found, $F(2, 184) = .30$, $p = .74$.

Depression (CES-D). Since CES-D depression scores were significantly different between writing groups at baseline, a 2 Writing Condition (trauma, neutral) x 3 Training Condition (response, stimulus, no training) univariate analysis of covariance (ANCOVA) was conducted to control for baseline depression.

Hypothesis 10 was that trauma writing would reduce depression symptoms more than neutral writing from baseline to follow-up. Contrary to expectations, this was not found, Writing Condition $F(1, 183) = .53$, $p > .05$.

Hypothesis 11 was that among trauma writers, response training would lead to a greater reduction in depression symptoms than stimulus or no training, whereas no training differences were expected as a result of neutral writing, i.e., a Writing Condition x Training

Condition x Interval interaction. Contrary to expectations, this pattern was not found, $F(2, 183) = 1.24$, $p < .30$.

Physical illness symptoms (PILL). Hypothesis 10 was that trauma writing would reduce PILL physical illness symptoms more than neutral writing from baseline to follow-up. Participants reported a reduction in physical illness symptoms from baseline to follow-up, Interval $F(1, 177) = 17.43$, $p < .001$. While both trauma and neutral writing led to a reduction in physical symptoms, trauma writing did not reduce physical symptoms more than neutral writing from baseline to follow-up, Writing Condition x Interval interaction $F(1, 177) = .08$, $p = .78$.

Hypothesis 11 was that among trauma writers, response training would lead to greater reduction of PILL physical illness symptoms than stimulus or no training, whereas no training differences were expected as a result of neutral writing. Contrary to expectations this pattern was not found, Writing Condition x Training Condition x Interval $F(2, 177) = 1.12$, $p = .33$.

A summary of the results of hypotheses 1-11 are presented in Table 14.

Table 14.

Summary of Hypotheses 1-11

Category	Dependent Variable	Supported	Not Supported
Trauma writing > Neutral writing			
Hypothesis 1	HR		X
	SC		X
Hypothesis 4	Trauma symptom severity (DTS-short)	X	
	Trauma symptom frequency (DTS-short)	X	
Hypothesis 7	Valence (SAM)	X	
	Arousal (SAM)	X	
Hypothesis 10	Trauma symptom severity (DTS)		X
	Trauma symptom frequency (DTS)		X
	Depression symptoms (CES-D)		X
	Physical symptoms of illness (PILL)		X
Response training > Stimulus or No training			
Hypothesis 2	HR	X	
	SC		X
Hypothesis 5	Trauma symptom severity (DTS-short)		X
	Trauma symptom frequency (DTS-short)		X
Hypothesis 8	Valence (SAM)		X
	Arousal (SAM)		X
Hypothesis 11	Trauma symptom severity (DTS)		X
	Trauma symptom frequency (DTS)		X
	Depression symptoms (CES-D)		X
	Physical health symptoms of illness (PILL)		X
Response training > Habituation than Stimulus or No training			
Hypothesis 3	HR		X
	SC		X
Hypothesis 6	Trauma symptom severity (DTS-short)		X
	Trauma symptom frequency (DTS-short)		X
Hypothesis 9	Valence (SAM)		X
	Arousal (SAM)		X

Initial physiological reactivity as a predictor of outcomes at follow-up. Hypothesis 12 was that among trauma writers, greater HR and SC in session one would be associated with greater reductions in each outcome variable (trauma, depression, and physical illness symptoms). Further, a goal of the present study was to determine if response training enhances emotional processing, which would be evidenced if the relation between initial physiological reactivity (HR and SC) and psychological and physical health outcomes are found to be strongest among response trained trauma writers. To test Hypothesis 12, for trauma writing participants, a stepwise regression analysis was conducted regressing post minus pre difference scores for each of the outcome measures (trauma symptom severity (DTS), depression (CES-D) and physical illness (PILL) symptoms) onto the HR and SC session one difference scores (mean of minutes 3-8 of writing minus mean of last five minutes of baseline, mean of minutes 9-14 of writing minus mean of last five minutes of baseline, mean of minutes 15-20 of writing minus mean of last five minutes of baseline), HR and SC session one baseline scores (mean of last five minutes of baseline), training group[2], and the interaction of training group with each of the eight physiological independent variables (three session one HR difference scores, three session one SC difference scores, HR baseline score, and SC baseline score).

To assist with interpretation, if an interaction term entered in the stepwise regression analysis (at $p < .05$) without its constituent main effects, a simultaneous regression was conducted to include all significant terms (interactions and main effects) plus all the main effects constituting the interactions in the final model. Interaction effects were plotted in Figures 9-11 by the following process. Separate regression lines were computed and plotted for individuals one standard deviation above the mean on the continuous predictor to produce a "high" value (i.e. high heart rate) and one standard deviation below the mean of the continuous predictor to produce a "low" value (i.e. low heart rate). Beta values from the simultaneous regression model were used. All independent variables in the regression

[2] The three training groups (response, stimulus, and no-training) were coded in the regression by dummy-coding the response training variable and stimulus training variable. For the response training variable, response-trained participants were assigned a 1, and stimulus and no-training participants were assigned a 0. For the stimulus training variable, stimulus-trained participants were assigned a 1 and response and no-training participants were assigned a 0.

analyses were mean centered. Therefore, a zero on Figures 9-11 represents the average response on the independent variable for trauma writers.

Trauma symptom severity (DTS-SEV). Hypothesis 12 was that among trauma writers, greater HR and SC reactivity in session one would be associated with greater reductions in trauma symptom severity. As can be seen in Table 15, there was a pattern of consistent correlations DTS-SEV showing that decreases in trauma symptom severity from pre- to post-writing were associated with increases in heart rate and skin conductance throughout the writing period. A significant model emerged with one predictor (HR Min 3-8 x Response Training), Adjusted R square = .071; $F(1, 77)= 6.98$, $p = .01$. After this predictor was entered, the other predictors no longer explained a significant amount of variance in DTS-SEV.

As noted in the previous section, participants in all training conditions showed a decrease in severity of trauma symptoms at follow-up relative to their levels at baseline. However, response-trained participants with greater HR in minutes 3-8 of writing in session one showed the greatest decrease in severity of trauma symptoms at follow-up. Stimulus-trained and no training participants with higher HR showed a slightly greater decrease in severity of trauma symptoms at follow-up than those with low HR, however, this difference was not significant. As can be seen in Figure 9, this pattern of findings resulted in a HR Min 3-8 x Response Training interaction ($\beta = -.288$, $p = .01$, R square = .083).

Depression (CES-D). Hypothesis 12 was that among trauma writers, greater HR and SC in session one would be associated with greater reductions in depression symptoms. As can be seen in Table 15, there was a pattern of consistent correlations CES-D showing that decreases in depression symptoms from pre- to post-writing were associated with increases in

HR and decreases in SC throughout the writing period. A significant model emerged with one predictor (HR Min 3-8 x Response Training), Adjusted R square = .042; $F(1, 82) = 4.66$, $p = .034$. After this predictor was entered, the other predictors no longer explained a significant amount of variance in CES-D. Response-trained participants with greater HR in minutes 3-8 of writing in session one showed a decrease in depression symptoms at follow-up. Stimulus-trained and no training participants had similar levels of depression symptoms at follow-up regardless of whether they had high or low HR in minutes 3-8 of writing in session one. As can be seen in Figure 10, this pattern of findings resulted in a HR Min 3-8 x Response Training interaction ($\beta = -.232$, $p = .034$).

Table 15.

Zero-order correlations between Physiological Reactivity in Session One and Outcomes

	DTS-SEV (Follow up – Baseline)	CES-D (Follow up – Baseline)	PILL (Follow up – Baseline)
Response Training	-.052	-.080	.131
Stimulus Training	.068	-.058	-.150‡
SC Min 3-8	-.058	.050	-.041
SC Min 9-14	-.126	.015	-.087
SC Min 15-20	-.154‡	.027	-.042
HR Min 3-8	-.228†	-.142‡	-.084
HR Min 9-14	-.230†	-.078	.002
HR Min 15-20	-.215†	-.107	-.061
SC Baseline	.072	-.087	.285†
HR Baseline	-.051	.060	-.035
SC Min 3-8 x Response Training	.184‡	.169‡	.034
SC Min 3-8 x Stimulus Training	-.133	.004	.013
SC Min 9-14 x Stimulus Training	-.121	.011	.059
SC Min 9-14 x Response Training	.090	.130	-.064
SC Min 15-20 x Response Training	.090	.139	-.099
SC Min 15-20 x Stimulus Training	-.124	.010	.093
HR Min 3-8 x Stimulus Training	-.158‡	-.075	-.067
HR Min 3-8 x Response Training	-.288†	-.232†	-.252†
HR Min 9-14 x Response Training	-.223†	-.123	-.205†
HR Min 9-14 x Stimulus Training	-.209†	-.034	-.043
HR Min 15-20 x Stimulus Training	-.200†	-.039	-.072
HR Min 15-20 x Response Training	-.181‡	-.156‡	-.196†
SC Baseline x Response Training	-.093	-.203†	.250†
SC Baseline x Stimulus Training	.009	-.074	.148‡
HR Baseline x Stimulus Training	.022	.120	.031
HR Baseline x Response Training	-.110	.043	-.028

†Indicates $p < .05$
‡Indicates $p < .10$
*DTS-SEV refers to trauma symptom severity

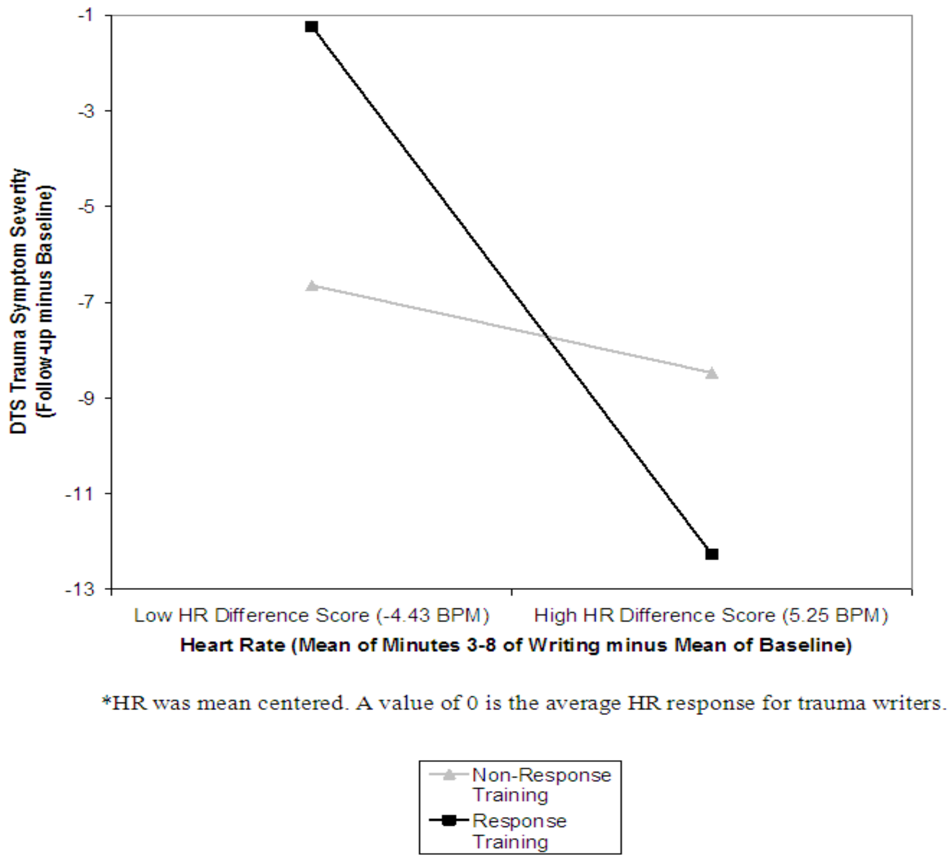


Figure 9. Heart Rate in Minutes 3-8 of Writing Session One as a Predictor of Severity of Trauma Symptoms at One Month Follow-up

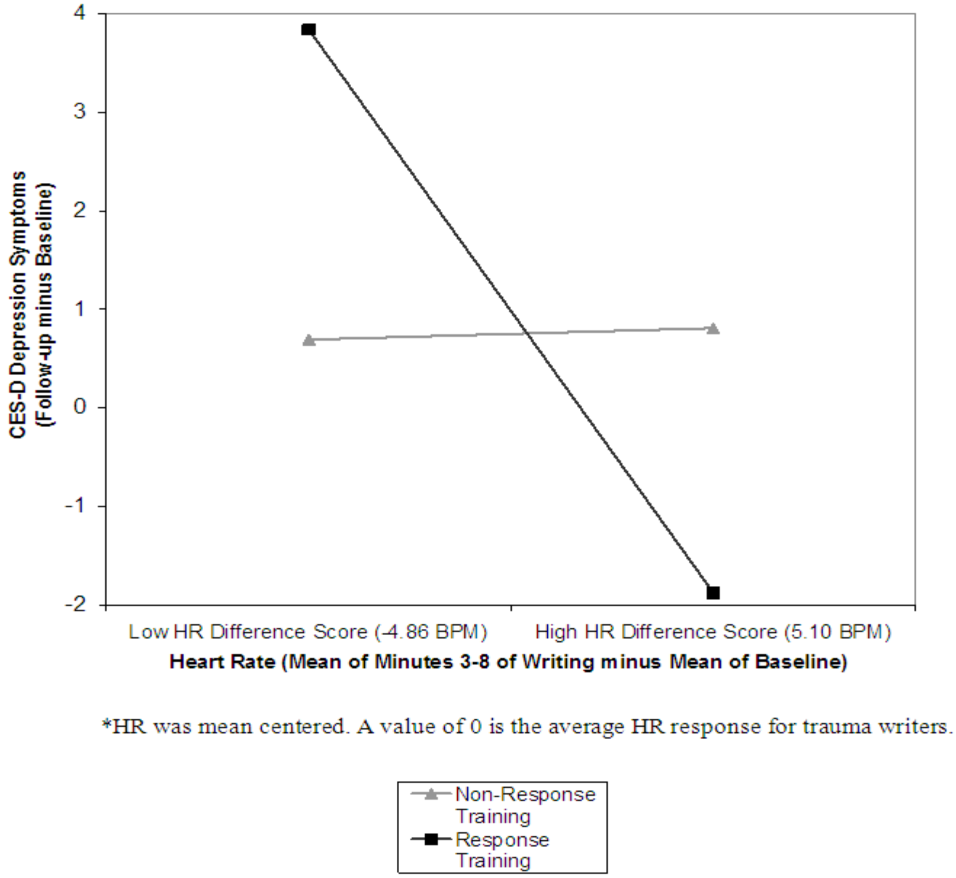


Figure 10. Heart Rate in Minutes 3-8 of Writing in Session One as a Predictor of Depression Symptoms at One Month Follow-up

Physical illness symptoms (PILL). Hypothesis 12 was that among trauma writing participants, greater HR and SC in session one would be associated with greater reductions in physical illness symptoms. As can be seen in Table 15, there was a pattern of consistent correlations PILL showing that decreases in physical illness symptoms from pre- to post-writing were associated with increases in HR and SC throughout the writing period. Using the stepwise method, a significant model emerged with three predictors (SC Baseline, Response Training, HR Minutes 3-8 x Response Training), Adjusted R square = .166;

F(3,75) = 6.18, *p* = .001. After these predictors were entered, the other predictors no longer explained a significant amount of variance in PILL.

Higher SC at baseline predicted increases in physical illness symptoms at follow-up from their initial levels, main effect for SC Baseline (β = .285, *p* = .011, Adjusted R square = .069). Response-trained participants reported more physical illness symptoms at follow-up compared to their initial levels than stimulus or no training participants, main effect for Response Training (β = .236, *p* = .038, Adjusted R square = .166). As can be seen in Figure 11, response-trained participants with greater HR, and stimulus-trained and no training participants with lower HR, showed the greatest decrease in frequency of physical illness symptoms at follow-up, HR Minutes 3-8 x Response Training interaction (β = -.263, *p* = .015, Adjusted R square = .13). As can be seen in Table 16, although all three of these predictors were significant in the initial stepwise regression, when HR Minutes 3-8 (the other constituent factor in the significant interaction term) was entered in the simultaneous regression, the only predictor that remained significant was the HR Minutes 3-8 x Response Training interaction.

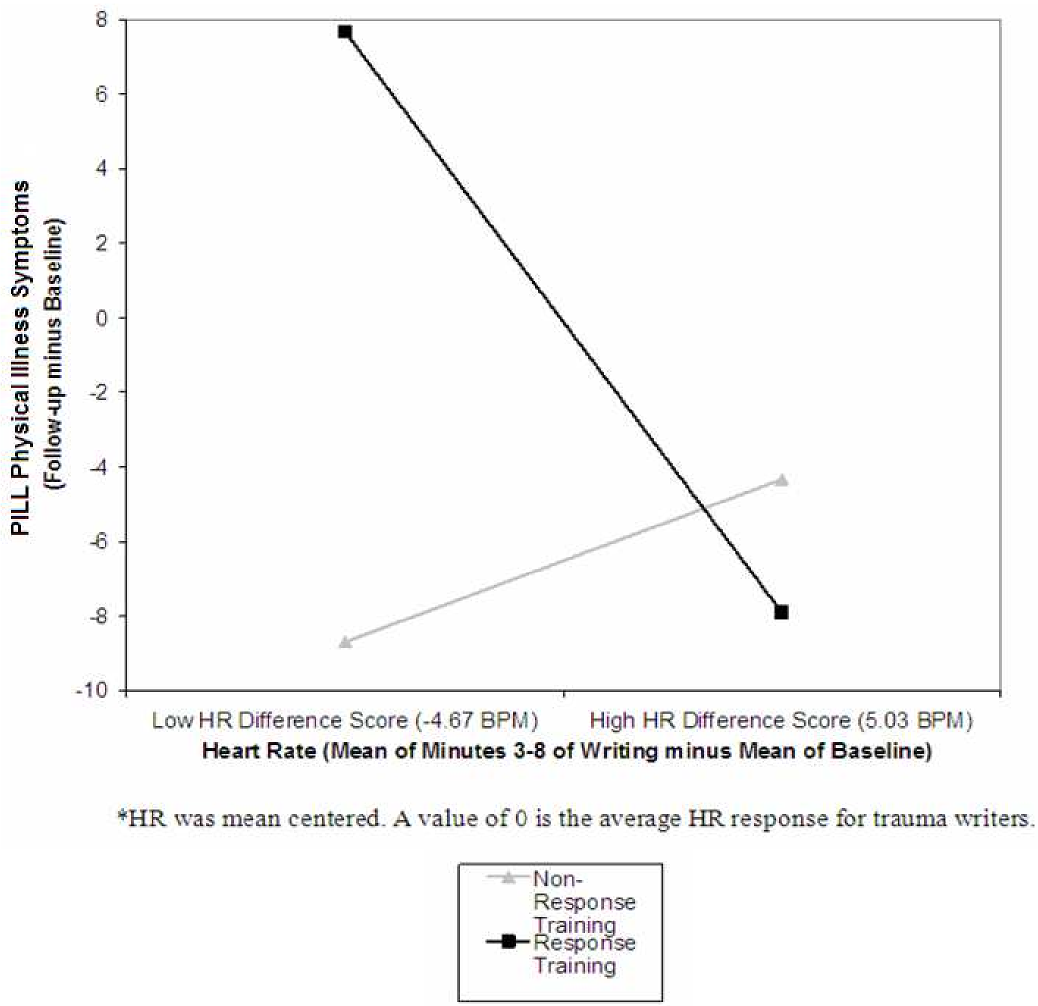


Figure 11. *Heart Rate in Minutes 3-8 of Writing in Session One as a Predictor of Physical Health Symptoms at One Month Follow-up*

Table 16.

Summary of Stepwise and Simultaneous Regression Analyses for Physiological Reactivity in Session One as Predictors of Outcome at Follow-up

Significant IVs	Stepwise Regression Results			Simultaneous Regression Results		
	Standardized Beta	t value	Unstandardized Beta	Standardized Beta	t value	Unstandardized Beta
DTS-SEV						
HR min 3-8				-.075	-.536	-.188
Response training				.067	.591	1.710
HR min 3-8* response training	-.288	-2.642†	-1.165	-.257	-1.814‡	-1.050
CES-D						
HR min 3-8				.009	.065	.012
Response training				.025	.230	.359
HR min 3-8* response training	-.232	-2.158†	-.518	-.271	-1.936‡	-.598
PILL						
SC baseline	.285	2.605†	10.578	.107	1.37	3.732
HR min 3-8				.120	.814	.450
Response training	.236	2.116†	9.017	.181	1.587	6.782
HR min 3-8* response training	-.263	-2.489†	-1.554	-.356	-2.403†	-2.056

†Indicates $p < .05$
‡Indicates $p < .10$
*DTS-SEV refers to trauma symptom severity

Discussion

The purposes of the current study were to 1) investigate whether response training is an effective tool for improving the effects of trauma writing, 2) expand knowledge about response training, 3) strengthen the connection between trauma writing as a form of exposure and traditional imagery exposure, and 4) encourage research on the use of trauma writing as a form of treatment.

Trauma writing increased HR and SC reactivity more than neutral writing, but contrary to expectations, these differences were not significant. As predicted, trauma writing significantly increased self-reported levels of unpleasantness and arousal, and post-traumatic stress symptoms, more than neutral writing. Further, trauma writers showed across-session habituation of self-reported unpleasantness and trauma symptoms, whereas neutral writers did not. These findings replicate previous research (Sloan et al., 2005; Sloan & Marx, 2004b) and indicate that trauma writing, like traditional imagery exposure, elicits an increase in self-reported emotion and trauma symptoms, which habituates across sessions.

There was some indication that response training had the intended effect of increasing physiological responding among trauma writers more than neutral writers. Response training increased HR reactivity to trauma writing compared to no training, whereas there were no training group differences found as a result of neutral writing. This finding indicates that response training increases appropriate physiological reactivity to trauma writing, as it has done in imagery research (Lang et al., 1983; Lang et al., 1980). This finding provides support for the hypothesis that trauma writing, like imagery, is a pathway through which emotional memories can be fully accessed, as evidenced by physiological responding. In contrast, response training did not lead to greater self-reported levels of unpleasantness and arousal, or trauma symptoms, than stimulus or no training. In sum, consistent with imagery findings (Lang et al., 1983; Lang et al., 1980), these results indicate that response training amplifies physiological reactivity to trauma writing more than neutral writing, without amplifying levels of self-reported emotion or trauma symptoms.

As predicted, response training amplified across-session habituation among trauma writers. Response-trained participants showed greater HR than no training participants in session one, but this difference did not exist by session three. In addition, response- and stimulus-trained trauma writers showed a decrease in self-reported arousal levels from session two to session three, whereas among response-trained neutral writers arousal levels increased from session one to session two. These findings indicate that response training facilitated across session habituation of both physiological reactivity and self-reported arousal elicited by trauma writing.

It was predicted that trauma writing would reduce trauma, depression and physical illness symptoms more than neutral writing at one-month follow-up. It was also predicted that among trauma writers, response training would reduce these symptoms more than stimulus or no training. Contrary to predictions, from baseline to follow-up trauma, depression and physical illness symptoms decreased for both trauma and neutral writing conditions, and no training effects were found. However, consistent with predictions and previous research (Sloan et al., 2004b; Epstein et al., 2005), initial physiological reactivity to trauma writing predicted psychological and physical health outcomes at follow-up. While increased HR predicted better outcomes for all trauma writers, response trained trauma writers who evidenced greater HR showed the greatest reductions in trauma, depression and physical illness symptoms at follow-up. These findings provide additional support for the assumption that writing is similar to traditional imagery exposure in that greater physiological reactivity at the beginning of writing was associated with good treatment outcomes. The findings are the first to demonstrate that response training facilitates emotional processing and could therefore be a beneficial adjunct to trauma writing.

In the following sections, these findings will all be discussed in more detail.

Trauma Writing Effects

Physiological reactivity. Trauma writing produced greater increases in HR and SC than neutral writing, but these differences were not significant, and effect sizes were small (HR: $d_{\text{effect size}} = .04$; SC: $d_{\text{effect size}} = .17$). Only two studies have compared the effect of trauma and neutral writing on HR. In the first study, which like the current study employed non-screened college student participants, trauma writing was found to increase HR more than neutral writing and the effect was large ($r_{\text{effect size}} = .42$) (Epstein et al., 2005). In the second study, in which participants were college students with at least moderate levels of post-traumatic stress symptoms, trauma writing focused on emotional content was found to increase HR more than trauma writing focused on making meaning of the event and neutral writing ($r_{\text{effect size}} = .33$) (Sloan et al., 2007).

Only one previous study has compared the effect of trauma and neutral writing on SC (Petrie et al., 1995). While inspection of the means indicated that trauma writing increased initial SC more than neutral writing, this effect was not tested statistically. Another study found SC reactivity to trauma writing increased significantly more when negative emotion words were used in trauma writing than when positive emotion words were used; however, no neutral writing comparison was employed (Hughes et al., 1994).

The fact that trauma writing did not elicit significantly greater physiological reactivity than neutral writing may be due to the imagery training conducted in this study. It is possible that imagery training elicited physiological reactivity during writing for both the neutral and trauma groups. In fact, response training increased HR more than no training across both writing conditions. In retrospect, this finding may be a result of the neutral writing instructions in combination with response training. The standard instructions developed by Pennebaker (1997) were used, which ask neutral writers to write about their daily activities. Participants in the response training condition were also instructed to "do in your recollection what you would do in the real situation". Since neutral writers were asked to write about their daily activities, and response training elicits appropriate physiological reactivity by facilitating access of motor programs, it may be that response training elicited increased physiological response to writing about emotionally neutral activities that involve physiological mobilization (like biking to school). Similarly, response training was found to amplify situation-appropriate HR reactivity to imagined action and exercise scenes (Lang et al., 1983; Lang et al., 1980). Thus, in imagery research non-action oriented neutral images (i.e. sitting in the living room) were deliberately used as a control condition (Lang et al., 1983; Lang et al., 1980). Because neutral writers were asked to write about their day, the extent to which their writing was action oriented could not be controlled.

Physiological responding among neutral writers may have also been amplified due to baseline differences in self-reported emotion. At baseline, those assigned to neutral writing had lower levels of pleasantness and higher levels of depression symptoms than those assigned to the trauma group. Further, neutral writers showed decreased levels of arousal from before to after writing, indicating that neutral writers had elevated arousal levels at baseline. Given that negative emotion is associated with increased physiological response (Davydov, Zech & Luminet, 2011; Hughes et al., 1994), it is possible that elevated levels of negative emotion among neutral writers led to emotional responding during writing as evidenced by increased physiological reactivity.

In sum, it is likely that physiological reactivity was amplified among neutral writers as a result of both response training and elevated baseline levels of self-reported emotion. Increased physiological reactivity in the control condition would make it difficult to find significant group differences.

Self-reported trauma symptoms and emotion. As predicted based on previous studies, trauma writing resulted in greater trauma symptoms, increased levels of unpleasantness, and more arousal than neutral writing (Sloan et al., 2005; Sloan & Marx, 2004b). Unexpectedly, neutral writers showed decreased levels of arousal after writing compared to before writing. Neutral writers may have had elevated arousal levels before writing due to anticipation of potentially writing about a traumatic event or due to uncertainty about being in an experiment. Once neutral writers had finished writing in each session, this anticipatory anxiety was likely alleviated, leading to a decrease in arousal levels.

Since trauma symptoms were assessed only after writing in each session, it is possible that trauma symptoms were elevated prior to writing. There is evidence suggesting this may have been the case, as trauma writers reported (nonsignificantly) higher levels of arousal at baseline in sessions two and three than at baseline session one, suggesting anticipation of writing about their traumatic event based on their experience in the first session. This anticipatory anxiety may have been accompanied by an increase in pre-writing trauma symptoms. Future research could examine trauma symptoms before and after writing to determine whether this is the case. However, assessing trauma symptoms immediately before each writing session would likely elicit the trauma memory and confound the subsequent responding of neutral writers.

In sum, trauma writing led to significantly greater self-reported emotion but not physiological response than neutral writing, indicating that self-reported emotion was more robustly affected by trauma writing than physiological responding. In imagery research also individuals may report high levels of emotion to fear imagery, but fail to exhibit synchronous increases in physiological responding (Lang et al., 1983; Weerts et al., 1978; Marks et al., 1973). According to bio-informational theory, stimulus and meaning units of a memory are processed as "knowledge about" the memory and are more easily accessed than response units, which include physiological responding (Lang, 1984). In the current study, trauma writers were asked to put their emotional memory into words, which involves accessing "knowledge about" the situation. Only response-trained trauma writers were asked to focus on their physiological responses to the event. Thus, it is appropriate that self-reported emotion, which reflects access of "knowledge about" the situation, was found to be more robust than physiological responses. Finally, self-report data would be expected to be more robust than physiological responses since physiological responses are also sensitive to internal and environmental stimuli which can lead to more measurement error (Dawson, Schell & Filion, 2000; Lacey, 1959).

Outcomes at follow-up. From baseline to one month post writing, trauma, depression, and physical illness symptoms decreased for both trauma and neutral writing groups among all training conditions. Earlier studies found that trauma writing led to greater reductions in psychological and physical symptoms than neutral writing at a one month follow-up (Epstein et. al., 2005; Sloan et. al., 2004b; Sloan, et. al., 2005). However, consistent with the current findings, recent writing research employing college student and general populations found significant improvements in psychological and physical health at follow-up compared to baseline for trauma and neutral writers with no significant group differences observed (Kearns et al., 2010; Daniels, 2009; Smyth et al., 2008).

The current finding that trauma writing did not improve symptoms of physical illness more than neutral writing is also consistent with a meta-analysis in which trauma writing was not found to improve symptoms of physical illness (Frattaroli, 2006). Further, larger effect sizes were found for psychological health outcomes when studies employed non-college student populations, participants screened for a trauma history, when writing occurred at home, and when follow-ups were conducted less than one month post writing (Frattaroli, 2006). In the current study, participants were college students not screened for a trauma history, writing took place in a laboratory setting, and follow-up occurred one month post writing. Thus, each of these factors likely contributed to the current findings that trauma writing did not lead to greater reductions in trauma and depression symptoms than neutral writing.

Imagery Training Effects

Physiological reactivity. Response trained participants had greater HR than no training participants, with stimulus participants between the two and not significantly different from either. Although these training effects were apparent across both writing groups, there was some indication that response training affected HR among trauma writers more than neutral writers. Response trained trauma writers showed greater HR than no training participants, whereas among neutral writers no significant training effects were found. These findings mirror imagery research, which found that response trained participants had greater HR than stimulus trained participants to fear and action scenes, and greater HR to fear and action scenes than to neutral scenes (Lang et. al., 1983, Lang et. al., 1980).

The more robust finding that response training increased physiological reactivity across both writing groups may be due to the action focus of the neutral writing instructions. As was argued when discussing physiological reactivity to writing, the action focus of the neutral writing instructions combined with response training likely led to amplified physiological responding among neutral writers.

It was predicted that response training would increase SC to trauma writing more than stimulus or no training. However, it was found that stimulus trained trauma writers had greater SC than stimulus trained neutral writers. There is no obvious theoretical explanation for this finding; it may be a chance finding and since this was the first study to examine the effect of response training on SC reactivity to trauma writing. This finding should be replicated before it is interpreted further.

Response training increased HR, but not SC, to trauma writing more than stimulus or no training. This finding replicates imagery studies in which response training had greater effects on cardiovascular responses than on skin conductance responses during processing of affective and action scenes (Lang et. al., 1980; Lang et. al., 1983; Miller et. al., 1987). Unlike heart rate, skin conductance is primarily responsive to external stimulation and stimulus habituation (Lang et. al., 1980). Since SC is more sensitive to external stimulation, it was expected to be more reactive to writing than imagery; however this was not the case.

Self-reported trauma symptoms and emotion. Response training did not amplify self-reported emotion or trauma symptoms more than stimulus or no training. Together the findings are consistent with imagery research (Miller et al., 1987; Lang et al., 1983; Lang et al., 1980), in that response training amplifies physiological activity to trauma writing, without amplifying self-reported emotion or trauma symptoms. According to bio-informational theory, stimulus and meaning units of a memory are processed as "knowledge about" the memory and are more easily accessed than response units, which include physiological responding (Lang, 1984). Both trauma writing and imagery require individuals to focus on an emotional memory, which involves accessing "knowledge about" the situation through mental pictures and words. In contrast, response training asks individuals to focus solely on their physiological responses to the event. Thus, it is appropriate that self-reported emotion, which reflects access of "knowledge about" the situation, was not found to be amplified by response training which targets physiological responding.

Habituation Effects

Physiological reactivity. As predicted, response trained trauma writers showed greater HR than no training trauma writers in session one, but this difference was not significant by session three, suggesting habituation across sessions. Stimulus trained trauma writer's HR fell between response and no training trauma writers in session one, and was not significantly different from any training condition in sessions one or three. As expected for neutral writers, there were no significant differences in HR among training conditions in either session. The finding that habituation of HR occurred for trauma writers, but not neutral writers, replicates previous findings (Sloan et al., 2007; Epstein et al., 2005) and is consistent with bio-informational theory. According to the theory, neutral writers who wrote about non-emotional behaviors would not be expected to habituate across sessions since physiological responding is behavior specific (Lang et al., 1983). For example, neutral writers were asked to write about non-emotional daily activities, such as walking and speaking which involve HR mobilization. Since HR mobilization is inherent in these actions, HR would not be expected to habituate. In contrast, trauma writers would be expected to show across session habituation because as an emotional memory is processed, behavioral tendencies would be expected to change. For example, trauma writers may have written about an emotional event which involved a strong response unit connection with the need to escape, thus producing a strong HR response. As the memory is processed, the behavioral tendency to escape, and thus the response unit connection with escape, would be expected to lessen leading to reduced HR across sessions.

This was the first study to examine the effects of response training on habituation. The results indicate that response training facilitates across session habituation of HR reactivity elicited by trauma writing. Contrary to predictions, response training did not facilitate across session habituation of SC reactivity. This is likely because response training did not increase SC reactivity to trauma writing more than stimulus or no training. Without SC reactivity among response trained trauma writers, habituation could not occur.

Self-reported trauma symptoms and emotion. Trauma writing led to greater habituation in self-reported trauma symptoms and unpleasantness across sessions than neutral writing. These findings replicate previous research (Epstein et al., 2005; Sloan et al., 2004b; Sloan et al., 2005) and indicate that trauma writing, like imagery exposure, elicits an increase in trauma symptoms and self-reported emotion which habituates across sessions (Minnen & Foa, 2006; Foa et al., 1986).

Response training also facilitated habituation of self-reported arousal among trauma writers. Inspection of arousal means indicated that from before to after writing, response trained trauma writers' arousal levels increased in session one, stayed the same in session two and decreased in session three. While a similar pattern was observed for stimulus and no training trauma writers, the decrease in arousal in session three was greatest for response trained trauma writers.

Together, the findings indicate that the physiological reactivity and self-reported emotion elicited by trauma writing habituates across sessions and response training enhances these effects. This is important because across session habituation of physiological reactivity and self-reported emotion is an indicator of memory processing in both writing (Sloan et al., 2007; Sloan et al., 2005) and imagery research (Minnen & Foa, 2006; Foa et al., 1986).

Initial physiological reactivity as a predictor of outcomes

According to the bio-informational theory (Lang, 1984), individuals can typically activate stimulus and meaning units, which include "knowledge about" a memory, but often have difficulty accessing response units, which include physiological reactivity to the event. To completely access and subsequently process an emotional memory, all three types of units (stimulus, response and meaning) must be activated (Lang, 1979), and complete emotional memory access is necessary for emotional memory change to take place (Foa et al., 1986). Thus, greater initial physiological reactivity to imagery exposure (Foa et al. 1986; Lang et al., 1970; Watson et al., 1971) and trauma writing (Sloan & Marx, 2006; Sloan et al., 2004b; Epstein et al., 2005) is associated with better psychological and physical health outcomes. Greater initial physiological reactivity indicates that the response units of the memory network have been accessed and thus the memory structure is available for modification. In contrast, a lack of physiological reactivity at the beginning of exposure suggests that the memory network, the target of the exposure intervention, has not been fully accessed and therefore cannot be fully processed, resulting in poorer treatment outcomes. In imagery research, response training has been effective in increasing physiological reactivity by amplifying pre-existing response dispositions (Lang et al., 1983; Lang et al., 1980; Miller et al., 1987).

This is the first study to examine whether response training enhances emotional processing and improves outcomes. If response training enhances emotional processing, then it would be expected that the relation between initial physiological reactivity (HR and SC) and psychological and physical health outcomes would be strongest among response trained trauma writers.

Emotional processing effects. Replicating previous research (Epstein et. al., 2005), there was a consistent pattern of correlations indicating that increased HR to trauma writing in session one was associated with decreases in trauma, depression and physical illness symptoms at follow-up. Increased SC to trauma writing in session one was associated with decreases in trauma and physical illness symptoms, however these effects were not as strong as those observed for HR (see Table 15).

It was unknown which part of the writing period in session one would produce physiology sensitive to the effects of trauma writing. Thus, writing was divided into three periods, which were included in regression analyses. HR and SC responding throughout the first writing session was predictive of outcomes, however once HR at the beginning of the session (the first period) was entered into the analyses, the other variables no longer added any explanatory variance.

While increased HR predicted better outcomes for all trauma writers, response trained trauma writers who evidenced greater HR showed the greatest reductions in trauma, depression and physical illness symptoms at follow-up. These results replicate previous findings that greater HR reactivity to trauma writing was associated with greater reductions in depression and physical illness symptoms at a one month follow-up (Epstein et. al., 2005). The results are also consistent with findings that increased HR during imagery was associated with greater reductions in fear, anxiety and avoidance (Foa et. al., 1986; Lang et. al., 1970; Watson et. al., 1971). This is the first study to assess whether response training enhances emotional processing and improves outcomes. The findings indicate that while response training is not necessary to produce the association between initial physiological reactivity (HR and SC) and psychological and physical health outcomes, it does enhance this effect. Thus, the findings demonstrated that when response training facilitates access of response units, as evidenced by amplified physiological reactivity, emotional processing is enhanced, and trauma writing outcomes are improved.

Although no significant processing effects for SC were found, the data suggest that SC is an indicator of emotional processing. Inspection of the correlations in table 15 show that trauma writing elicited SC and HR, both of which indicate sympathetic nervous system output . Since both reflect the same sympathetic variance, once HR was entered into the regression equation, SC could not be entered because the variance it accounted for was already explained by HR. Thus during trauma writing, SC appears to be a less robust indicator of emotional processing. This was the first study to assess the association between initial SC reactivity to trauma writing and outcomes and these findings should be replicated to determine if they are reliable.

Study implications, future directions, and applications

The present study provides further support for the hypothesis that trauma writing is a form of exposure. The results indicate that trauma writing like traditional imagery exposure elicits an increase in physiological response and self-reported trauma symptoms and emotion which habituates across sessions. These findings strengthen the argument that trauma writing, like imagery is a pathway through which emotional memories can be processed and imply that trauma writing should be more broadly considered for use as an exposure intervention.

To the best of our knowledge, this is the first study to examine whether response training enhances emotional processing. The results demonstrate that response training is a brief, cost effective technique which enhances emotional processing during trauma writing and improves outcomes. These initial findings indicate that response training improves outcomes in the short-term, one month post writing. An important next step would be to determine whether the improvements facilitated by response training are maintained over longer periods of time. This would be important to examine as other trauma writing studies show that the most dramatic benefits of writing are often seen more immediately following the intervention.

Since the current study employed a non-screened college student population, another important next step would be to determine whether these findings generalize to college student populations screened for a trauma history or to individuals with a diagnosis of PTSD. Recent research has found that physiological blunting is systematically more pronounced over the anxiety disorder spectrum as it has been found to be associated with a greater number of traumatic experiences, and greater chronicity, negative affectivity, and poorer prognosis (McTeague et al., 2010; Lang & McTeague, 2009). As such, individuals with more severe, chronic pathology may be most in need of a response training intervention prior to trauma writing. The number of traumatic experiences and chronicity of trauma symptoms were not assessed in the current study, thus future research should assess these variables to determine if they influence physiological responding to trauma writing and outcomes.

Finally, bio-informational theory suggests that language cues in internal processing (writing) or external communication (talking) can be media through which emotional memory networks are processed. Consistent with this theory, studies comparing the benefits of emotional disclosure through talking (to a therapist) and through writing found similar effects (Donnelly et al., 1991; Murray, Lamnin & Carver, 1989). Thus, since response training is effective in amplifying the benefits of writing, then it may also increase the efficacy of talk therapies for trauma symptom reduction aimed at promoting emotional processing, a question future research can address.

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Appendix A

Demographic Questionnaire

ID Number:

Name ____

1) Age __________
2) Gender __________
3) What is your Race? Please check **All that apply**:

American Indian/Alaska Native	
Asian	
Black or African- American	
Hispanic	
Native Hawaiian or Other Pacific Islander	
White	
Other	

4) What year are you in school? Please check one of the following:

Freshman	
Sophmore	
Juinor	
Senior	

5) Is English your native language? _____________
   If not, what is your native language? _____________

6) Are you currently receiving psychotherapy? _____________

7) Have you smoked cigarettes in the last 6 hours?_____________________

8) Have you used any other tobacco products in the last 6 hours? _______- If yes, what kinds?_______________________

9) Do you use any prescription medications?
   If yes, please list: ____

10) Please include your **e-mail address** to receive your Follow-Up Packet **one month from now:**

Appendix B

Davidson Trauma Scale

Intials:______________________
Date/session:__________________
Idnum:______________________

Please identify the trauma which
is most disturbing to you: ____

A. In the past week, how much trouble have you had with the following, keeping in mind the event described above.

	Frequency 0= Not at all 1= Once only 2= 2-3 times 3= 4-6 times 4= more than 6 times	Severity 0= Not at all distressing 1= Minimally distressing 2= Moderately distressing 3= Markedly distressing 4= Extremely distressing
1) Have you had painful images, memories or thoughts of the event?	________	________
2) Have you had distressing dreams of the event?	________	________
3) Have you felt as though the event was re-occurring?	________	________
4) Have you been upset by something which reminded you of the event?	________	________
5) Have you been avoiding any thoughts or feelings about the event?	________	________
6) Have you been avoiding doing things or going into situations which remind you about the event?	________	________
7) Have you found yourself unable to recall important parts of the event?	________	________
8) Have you had difficulty enjoying things?	________	________
9) Have you felt distant or cut off from other people?	________	________
10) Have you been unable to have sad or loving feelings?	________	________
11) Have you found it hard to imagine having a long life span fulfilling your goals?	________	________
12) Have you had falling asleep or staying asleep?	________	________
13) Have you been irritable or had outbursts of anger?	________	________
14) Have you had difficulty concentrating?	________	________
15) Have you felt on the edge, been easily distracted, or had to stay on guard?	________	________
16) Have you been jumpy or easily startled?	________	________
17) Have you been physically upset by reminders of the event?	________	________

Appendix C

Short Version of the Davidson Trauma Scale

Intials:_______________________
Date/session:__________________
Idnum:________________________

Please identify the trauma which is most disturbing to you: ____

A. In the past 10 minutes, how much trouble have you had with the following, keeping in mind the event described above.

	Frequency	Severity
	0= Not at all 1= Once only 2= 2-3 times 3= 4-6 times 4= more than 6 times	0= Not at all distressing 1= Minimally distressing 2= Moderately distressing 3= Markedly distressing 4= Extremely distressing
a. Have you had any painful images, memories or thoughts of the event?	____________	____________
b. Have you felt as though the event was reoccurring? Was it as if you were reliving it?	____________	____________
c. Have you been upset by something which reminded you of the event?	____________	____________
d. Have you been avoiding any thoughts or feelings about the event?	____________	____________
e. Have you found yourself unable to recall important parts of the event?	____________	____________
f. Have you had difficulty enjoying things?	____________	____________
g. Have you felt distant or cut-off from other people?	____________	____________
h. Have you been unable to have sad or loving feelings, or have you generally felt numb?	____________	____________
i. Have you been irritable or had outburst of anger?	____________	____________
j. Have you had difficulty concentrating?	____________	____________
k. Have you felt on edge, been easily distracted, or had to	____________	____________

stay on guard? | ______ | ______

stay on guard?		
l. Have you been jumpy or easily startled?		
m. Have you been physically upset by reminders of the event? (This includes sweating, trembling, racing heart, shortness of breath, nausea, diarrhea.)		

Appendix D

Center for Epidemiological Studies-Depression Scale (CES-D)

CES-D

Below is a list of the ways you might have felt or behaved. Please check the appropriate box to tell how often you have felt this way during the past week.

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by things that usually don't bother me.	☐	☐	☐	☐
2. I did not feel like eating; my appetite was poor.	☐	☐	☐	☐
3. I felt that I could not shake off the blues even with help from my family or friends.	☐	☐	☐	☐
4. I felt I was just as good as other people.	☐	☐	☐	☐
5. I had trouble keeping my mind on what I was doing.	☐	☐	☐	☐
6. I felt depressed.	☐	☐	☐	☐
7. I felt that everything I did was an effort.	☐	☐	☐	☐
8. I felt hopeful about the future.	☐	☐	☐	☐
9. I thought my life had been a failure.	☐	☐	☐	☐

10. I felt fearful.	☐	☐	☐	☐
11. My sleep was restless.	☐	☐	☐	☐

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
12. I was happy.	☐	☐	☐	☐
13. I talked less than usual.	☐	☐	☐	☐
14. I felt lonely.	☐	☐	☐	☐
15. People were unfriendly.	☐	☐	☐	☐
16. I enjoyed life.	☐	☐	☐	☐
17. I had crying spells.	☐	☐	☐	☐
18. I felt sad.	☐	☐	☐	☐
19. I felt that people disliked me.	☐	☐	☐	☐
20. I could not get "going".	☐	☐	☐	☐

Appendix E

The Pennebaker Inventory of Limbic Languidness (PILL)

Several common symptoms or bodily sensations are listed below. Most people have experienced most of them at one time or another. We are currently interested in finding out how prevalent each symptom is among various groups of people. On the page below, write how frequently you experience each symptom. For all items, use the following scale:

1	2	3	4	5
Have never or almost never experienced the symptom	Less than 3 or 4 times per year	Every month or so	Every week or so	More than once every week

______ 1 Eyes Water
______ 2 Itchy eyes or skin
______ 3 Ringing in ears
______ 4 Temporary deafness or hard of hearing
______ 5 Lump in throat
______ 6 Choking sensations
______ 7 Sneezing spells
______ 8 Running nose
______ 9 Congested nose
______ 10 Bleeding nose
______ 11 Asthma or wheezing
______ 12 Coughing
______ 13 Out of breath
______ 14 Swollen ankles
______ 15 Chest pains
______ 16 Racing heart
______ 17 Cold hands or feet even in hot weather
______ 18 Leg cramps
______ 19 Insomnia or difficulty sleeping
______ 20 Toothaches
______ 21 Upset stomach
______ 22 Indigestion
______ 23 Heartburn or gas
______ 24 Abdominal pain
______ 25 Diarrhea
______ 26 Constipation
______ 27 Hemorrhoids
______ 28 Swollen joints
______ 29 Stiff or sore muscles
______ 30 Back pains
______ 31 Sensitive or tender skin
______ 32 Face flushes
______ 33 Tightness in chest
______ 34 Skin breaks out in rash
______ 35 Acne or pimples on face
______ 36 Acne/pimples other than face
______ 37 Boils
______ 38 Sweat even in cold weather
______ 39 Strong reactions to insect bites
______ 40 Headaches
______ 41 Feeling pressure in head
______ 42 Hot flashes
______ 43 Chills
______ 44 Dizziness
______ 45 Feel faint
______ 46 Numbness or tingling in any part of body
______ 47 Twitching of eyelid
______ 48 Twitching other than eyelid
______ 49 Hands tremble or shake
______ 50 Stiff joints
______ 51 Sore muscles
______ 52 Sore throat
______ 53 Sunburn
______ 54 Nausea

In the last month, how many:

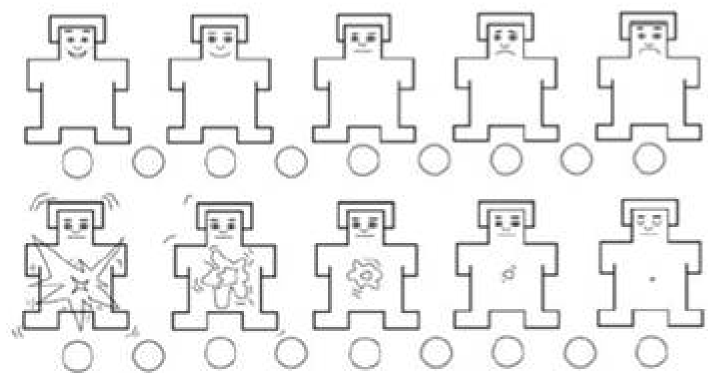
_____ _____ Visits have you made to the student health center or private physician for illness?

_____ _____ Days have you been sick?

__________ Days has your activity has been restricted due to illness?

Appendix F

Self-Assessment Manikin (SAM)



Appendix G

Imagery Response Training Protocol

Imagery Response Training Protocol

"Today we'll begin by teaching you to relax through the use of a breathing technique. This technique, called diaphragmatic breathing, has been found to be effective for reducing feelings of tension. Essentially, there are two ways of breathing-- from the chest, or from the diaphragm. With chest breathing, the chest expands with each inhalation, while the abdomen remains relatively motionless. When breathing from the diaphragm, the stomach or abdomen expands as the diaphragm moves downward to allow air to fill the lungs. We now know that when we breathe predominantly from our chest that this can create bodily tension, and that when we breathe with our diaphragm we can create feelings of relaxation. I will teach you this technique so you can use it later to relax before writing.

"Now I would like for you to practice this breathing technique. First, place one hand on your chest and the other on your abdomen, like this (*demonstrate*). Next, inhale slowly through your nose and try to make the hand on your abdomen rise. Try to push up your hand as much as it feels comfortable. Your chest should move slightly, but not more than your abdomen. After you've taken a full breath, pause for a second, and then exhale slowly and fully through your nose or mouth and count to one to yourself as you exhale. As you practice this procedure, imagine that there is a balloon in your stomach, and that each time you inhale, the balloon inflates and each time you exhale, the balloon deflates." (*Demonstrate this breathing technique for 30s*).

"Do you have any questions?"

"Now I would like for you to practice this technique for a few minutes with your eyes closed. Again, try to imagine a balloon inflating and deflating in your stomach as you practice this technique. Concentrate on your abdomen moving up and down, the air moving in and out of your lungs, and the feelings of relaxation that deep breathing gives you."

Have subject practice for 3 minutes. Watch, and provide feedback (minimal) about whether he/she is doing the procedure correctly.

After 3 minutes, if the subject is not doing the procedure correctly, additional practice may be needed. Thus, explain the procedure again reading from the bolded paragraph above. If the subject is breathing correctly, continue with the next part of the experiment. For every subject, say the following line before continuing to the next part.

How did that feel?
(For some people it is not relaxing. If it is not relaxing for you, you can just close your eyes and breathe when you are instructed to relax.)
"You will be asked to use this breathing technique later in the experiment. Do you have any questions?"

As mentioned earlier, I will ask you to write about an event in your life and we will do this in a little while. When you write you will be calling upon memories of the experience. I want to share with you a technique that I want you to use that will help you recall and visualize the experience. I would like to help you learn to be able to vividly recall the feelings of the actual experience.

Imagery Response Training

"As I mentioned earlier, visualization, or vividly imagining scenes and events, is part of our experimental procedure. We will begin this phase of the experiment now. I'd like you to practice visualizing some commonplace scenes. It is like daydreaming, but I'd like you to bring this more under your control, to imagine specific events, for a given period of time. It will help you to do this if you remain relaxed, as you've learned.

As you are sitting there, deeply relaxed, completely calm, I'd like you to try some scenes. Try to imagine these situations as vividly as you can. Involve yourself fully in the image as an active participant in the imagined scene. For example, the first scene I will ask you to imagine involves reading a book. I want you to try to move your eyes in the image just as if you were actively scanning the words and lines of a real book. The idea of a vivid image is that you get the feeling of a real, actual experience.

As I describe the scenes, create the image in your mind, doing exactly what you would do in the real situation. When I finish the description, keep imagining the scene until I tell you to stop and focus on relaxation. Now I will present the first scene. Please close your eyes and keep them closed until I tell you to open them."

"**You are sitting in a chair reading a popular science magazine. Your eyes dart from word to word and from line to line down the page as you make rapid progress through the text. You shift to a full page illustration of the muscles of the arm, and you look up and down all over the page, noting first the hand on the upper right corner of the page, then inspecting the elbow in the center, and finally the upper arm muscles in the lower left part of the page. You turn the page, and your eyes follow the text into the next chapter**."

Have subject imagine scene for 20s

"Now open your eyes."

"How were you able to imagine the scene?"

"Did you move your eyes in the image?"

"Did you move your hand in the image?"

"Remember, it is important to scan the book with your eyes in the image just as if you were looking at a real book. A vivid image depends on making the scene like a real, actual experience. You must do in the image what you would do in the real situation."

"Alright, now that we've reviewed the idea of vividness, let's try another scene. Don't worry if the first scene wasn't very vivid. Some people are initially better than others at this, but practice will help everyone to imagine events as if they are really happening. We're ready to try again."

"Close your eyes and take a few seconds to get in a comfortable position and relax again. (*20s*).

"Remember, what we are trying to learn is vivid imagery through your active participation in what you imagine. Just like with the last scene, this means doing just what the image requires. For example, the next image involves muscle tension you feel while you are reading. I want you to actually tense your muscles in imagining this. This will make the image more vivid, that is, more like an actual experience of the scene I present.

Now I will present the scene. Create the image in your mind, doing exactly what you would do in the real situation. When I finish the description, keep imagining the scene until I tell you to stop. Here is the next scene. Please close your eyes and keep them closed until I tell you to open them."

"**You are in the language laboratory listening to an assignment over headphones, and following the conversation with your book. You listen to the words and follow the script from line to line down the page. Your neck and shoulder muscles are tense and stiff from being held so long in the same position. Trying to concentrate, you tense the muscles in your forehead and around your eyes, and you feel a full headache. Taking off the headphones, you breathe deeply and get up from the desk for a break**."

Have subject imagine scene for 20s

"Now open your eyes."

"How were you able to imagine the scene?"

"Did you tense your muscles in the image?"

"Did you move your eyes in the image?"

"Did you take the deep breath?"

"It is important to do in the scene what you would do in the real situation. This means things like tensing your muscles, moving your eyes, and breathing deeply. Many of us are not used to this type of vivid imagery, and the point of this portion of the experiment is for you to learn to practice this kind of active involvement in your images."

"Let's practice another scene again. Sit back, close your eyes, and get relaxed. Try to focus on breathing deeply from your diaphragm." (*20s*)

"Now that you are sitting there, deeply relaxed, completely calm, I'd like you to imagine another situation. Try to imagine the scene as vividly as you can."

"**You are standing at the base of an observation tower as some of your friends ascend the stairs. Your eyes follow their hands, gliding upwards on the handrails, as they slowly climb the metal staircase. You tense the muscles on your face, squinting to avoid the sun, which glints through the metalwork of the tower. Craning your neck, you continue to watch closely, following with your eyes their steady upward progress toward the observation deck. They reach the top, and you look up as someone drops a hat. You follow the hat with your eyes while it sails gently down to the ground at you feet**."

Have subject imagine scene for 20s

"Now open your eyes."

"How were you able to imagine the scene?"

"Did you move your eyes in the image?"

"Did you use the muscle in your face and neck?"

"Recall that I want you to move your eyes in the image just as if you were looking up and down a real tower. Likewise, you are to tense the muscles used in the image. Actually do what you would do in the real situation."

"Close your eyes and relax. We'll do another scene. I'll give you a few seconds to get relaxed, and then we'll go into the next scene." (*20s*)

"You are doing some isometric exercises and you look at the diagram in your exercise book. It is a schematic diagram, showing only the muscles themselves. It shows the face and the neck muscles, and you glance up and down the whole page, while you note the muscles involved in the exercise. You breathe deeply and tense all the muscles in your face and neck. Your heart races and sweat beads up on your forehead with strain."

Have subject imagine scene for 20s

"Open your eyes."

"How were you able to imagine the scene?"

"Did your heart beat change any? How about sweating?"

"Did you tense your muscles? Which ones? Did you breathe deeply?"

"This scene was a little different than the other ones we did, in that you were asked to imagine heart rate and perspiration changes. It may not be obvious that you can actually do these things in the images like you can with eye movements, muscle tension, and breathing changes, but don't let this concern you. The practice here with imagining these responses can help you to increase your skill."

"Okay, you have practiced a relaxation technique, and a way of achieving vivid imagery by doing in the scene what you would do in the real situation. The next part of this experiment will involve writing and I ask that you use the techniques you were just taught in order to more fully involve yourself in your writing.

How to reinforce the participant:

Reinforce response statements i.e. muscle movement, actions and perceptual movements. Ignore stimulus descriptions.

When response statements are reported you can say you did a good job with that. If the description did not involve response statements ask the participant if they experienced X. If they report that they did say "good, that will make your image more vivid." If they did not experience X provide corrective feedback i.e. in future images try to imagine that you are actually in the scene doing what is described. For example, if the scene states that your muscles are tense, actually tense your muscles as if you were experiencing the scene.

You can ask prompting questions such as "What did you do when the hat fell down?"
If the participant reports several response statements you can say, "It sounds like you had a very vivid image."

After the participant has described their image, the experimenter should summarize the image and provide reinforcement and corrective feedback when appropriate.

Avoid interrupting the participant because interruption can be a punisher.

Imagery Stimulus Training Protocol

"Today we'll begin by teaching you to relax through the use of a breathing technique. This technique, called diaphragmatic breathing, has been found to be effective for reducing feelings of tension. Essentially, there are two ways of breathing-- from the chest, or from the diaphragm. With chest breathing, the chest expands with each inhalation, while the abdomen remains relatively motionless. When breathing from the diaphragm, the stomach or abdomen expands as the diaphragm moves downward to allow air to fill the lungs. We now know that when we breathe predominantly from our chest that this can create bodily tension, and that when we breathe with our diaphragm we can create feelings of relaxation. I will teach you this technique so you can use it later to relax before writing.

"**Now I would like for you to practice this breathing technique. First, place one hand on your chest and the other on your abdomen, like this (*demonstrate*). Next, inhale slowly through your nose and try to make the hand on your abdomen rise. Try to push up your hand as much as it feels comfortable. Your chest should move slightly, but not more than your abdomen. After you've taken a full breath, pause for a second, and then exhale slowly and fully through your nose or mouth and count to one to yourself as you exhale. As you practice this procedure, imagine that there is a balloon in your stomach, and that each time you inhale, the balloon inflates and each time you exhale, the balloon deflates**." (*Demonstrate this breathing technique for 30s*).

"Do you have any questions?"

"Now I would like for you to practice this technique for a few minutes with your eyes closed. Again, try to imagine a balloon inflating and deflating in your stomach as you practice this technique. Concentrate on your abdomen moving up and down, the air moving in and out of your lungs, and the feelings of relaxation that deep breathing gives you."

Have subject practice for 3 minutes. Watch, and provide feedback (minimal) about whether he/she is doing the procedure correctly.

After 3 minutes, if the subject is not doing the procedure correctly, additional practice may be needed. Thus, explain the procedure again reading from the bolded paragraph above. If the subject is breathing correctly, continue with the next part of the experiment. For every subject, say the following line before continuing to the next part.

How did that feel?
(For some people it is not relaxing. If it is not relaxing for you, you can just close your eyes and breathe when you are instructed to relax.)

"You will be asked to use this breathing technique later in the experiment. Do you have any questions?"

As mentioned earlier, I will ask you to write about an event in your life and we will do this in a little while. When you write you will be calling upon memories of the experience. I want to share with you a technique that I want you to use that will help you recall and visualize the experience. I would like to help you learn to be able to vividly recall the feelings of the actual experience.

"As I mentioned earlier, visualization, or vividly imagining scenes and events, is part of our experimental procedure. We'll begin this phase of the experiment now. I'd like you to imagine some situations. I'll be reading descriptions of the events to help you imagine them. It is like daydreaming, but I'd like you to bring this more under your control, to imagine specific events, for a given period of time. It will help you to do this if you remain relaxed, as you've learned.

As you sit there, relaxed and calm, I'd like you to imagine some events. Try to imagine the situations as vividly as you can. Picture the scene in your mind as clearly as possible. For example, the first scene I will ask you to imagine involves reading a magazine. I want you to visualize the picture of the magazine with as much detail as you can, just as if the book were real. The idea of a vivid image is that you get a realistic picture of the scene in your mind.

Now I'll set up the image. As I describe the situation, create the image in your mind, getting a detailed picture of what the real situation would be like. When I finish the description, keep imagining the scene until I tell you to stop and focus on relaxation. Now I will present the first scene. Please close your eyes and keep them closed until I tell you to open them."

"**You are sitting in a chair reading a popular science magazine. You see the words in paragraphs in black ink. You shift to a full page illustration of the muscles of the arm, and you notice that different colors are used to illustrate different parts of the arm, noting first the hand, which is yellow, then inspecting the elbow which is green, and finally the upper arm muscles which are shown in orange. You notice the fine detailed lines of the muscles in each part of the arm.**

Have subject imagine scene for 20s

"Now open your eyes."

"How were you able to imagine the scene?"

"Were you able to see the words in paragraphs in black ink?"

"Were you able to see the different muscles of the arm in the different colors?"

"Were you able to see the fine detailed lines of the muscles in each part of the arm?"

"Remember, it's very important to include in the picture all the details that you can, and to visualize the scene just as if it were really happening. A vivid image depends on your having a realistic picture in your mind. Many of us aren't used to this way of imagining things vividly, and the point of these group sessions is for you to learn and practice this kind of active involvement with your imagery. A vivid image depends on your making the picture look as real as possible. You must include in the image colors, shapes, sizes, and relationships. This can help you to have more realistic images.

All right, now that we've reviewed the ideas of vividness, let's try another scene. Don't worry if the first scene wasn't very vivid. Some people are initially better than others at this, but practice will help everyone to imagine events as if you were really seeing them. We are ready to try again."

"Close your eyes and take a few minutes to get in a comfortable position and relaxed again (20s)."

"Remember, what we're trying to learn is vivid imagery by your including as many details as possible in the picture in your mind. Just like in the last scene this means including colors, textures, and relationships, in the picture. For example, be involved in the next situation by attending carefully to the details of situation just as if they were right in your line of sight. This will make the image more vivid. Now I will present the scene. When I finish the description, keep imagining the scene until I tell you to stop. Here is the next scene. Please close your eyes and keep them closed until I tell you to open them. Here is the next scene."

"**You are in the language laboratory listening to an assignment over headphones and following the conversation with your book. The words flow too fast and the lines of text are a gray blur against the creamy white surface of the page. A color photograph of a farm on the adjoining page distracts you from the text. The texture of the page with the color plate is smooth looking and glossy, while the page with the text is rough and dull."**

Have subject imagine scene for 20s

"Now open your eyes."

"What did you see in the image?"

"Were you able to see gray blurred lines on the page?"

"Did you see colors in the photograph?"

"Did you see the glossy vs. dull textures?"

"It is important to include lots of details in the image, picturing the situation in your mind as if it were a real situation. Many of us are not used to this type of vivid imagery, and the point of this portion of the experiment is for you to learn to practice including details in your images.

"Let's practice another scene again. Sit back, close your eyes, and get relaxed. Try to focus on breathing deeply from your diaphragm." (*20s*)

"Now that you are sitting there, deeply relaxed, completely calm, I'd like you to imagine another situation. Try to imagine the scene as vividly as you can."

“You are at the base of an observation tower as some of your friends ascend the stairs. The sun glints through the metal staircase. Slowly they make upward progress toward the tower’s observation deck. They reach the top and wave to you from the platform. One of your friends drops a white hat, which gently sails down to the ground at your feet.”

Have subject imagine scene for 20s

“Now open your eyes.”

“What did you see in the image?”

“Did you see the gray tower, the sun, the platform?”

“Did you see the white hat falling?”

“It is important to include lots of details in the image, picturing the situation in your mind as if it were a real situation. Many of us are not used to this type of vivid imagery, and the point of this portion of the experiment is for you to learn to practice including details in your images.

"Let's practice another scene. Sit back, close your eyes, and get relaxed. Try to focus on breathing deeply from your diaphragm.”(20s)

"Now that you're sitting there, deeply relaxed, completely calm, I'd like you to imagine another situation. Try to imagine the scene as vividly as you can."
“Try to picture in your mind as much detail as you can, as if the situation were real.”

Close your eyes and relax again. An interesting thing about this training is that you can apply what you have learned to your images in a variety of settings. For example, the experiences you have when you watch a film or see a play are like the pictures you imagine here. If you are willing to focus on as many details as possible, the action on screen or on stage helps you to believe in the situation and picture it as if it were real. My picturing as many details as possible in your mind, you can experience situations as if they were real.”

“Close your eyes and relax. We’ll do another scene. I’ll give you a few seconds to get relaxed, and then we’ll go into the next scene.” (20s)

Close your eyes and relax again. (20 seconds) Let’s do another image now.

“You are flying a kite on the beach on a bright summer day. Your red kite shows clearly against the cloudless blue sky, and whips quickly up and down in spirals with the wind. The sun glares at you from behind the kite and makes the white sandy

beach sparkle with reflection. The long white tail dances from side to side beneath the soaring kite."

Have subject imagine scene for 20s

"Open your eyes."

"What did you see in the image?"

"What colors did you see?"

"Did you see the texture of the beach?"

"What shape was the kite?"

"I want to remind you again of the purpose of the imagery practice. You let yourself see situations as real by including lots of details about colors, shapes, sizes, etc., in your images. You have practiced a relaxation technique, and a way of achieving vivid imagery by including rich detail in the pictures in your mind. The next part of this experiment will involve writing and I ask that you use the techniques you were just taught in order to more fully involve yourself in your writing."

How to reinforce the participant:
Reinforce descriptive statements i.e. the sky is blue, or the sun is shining Ignore response statements i.e. muscle movement, actions and perceptual movements.

When stimulus statements are reported you can say you did a good job with that. If the description did not involve stimulus statements ask the participant if they experienced X. If they report that they did say "good, that will make your image more vivid." If they did not experience X provide corrective feedback i.e. in future images try to let yourself see situations as real by including lots of details about colors, shapes, sizes, etc., in your images.

You can ask prompting questions such as "What did the hat look like?"
If the participant reports several stimulus statements, you can say, "It sounds like you had a very vivid image."

After the participant has described their image, the experimenter should summarize the image and provide reinforcement and corrective feedback when appropriate.

Avoid interrupting the participant because interruption can be a punisher.

Appendix H

Writing Instructions

Writing Instructions

Overview of Writing Instructions Given to All Participants

This study is an extremely important project looking at writing. During the next three lab sessions, you will be asked to write about one of several different topics for 20 minutes each day.

The only rule we have about your writing is that you write continuously for the entire time. If you run out of things to say, just repeat what you have already written. In your writing, don't worry about grammar, spelling, or sentence structure. Just write. Different people will be asked to write about different topics. Because of this, I ask that you not talk with anyone about the experiment. Because we are trying to make this a tight experiment, I can't tell you what other people are writing about or anything about the nature or predictions of the study. Once the study is complete, however, we will tell you everything. Another thing is that sometimes people feel a little sad or depressed after writing. If that happens, it is completely normal. Most people say that these feelings go away in an hour or so. If at any time over the course of the experiment you feel upset or distressed, please tell your experimenter or contact Dr. Vrana immediately. [Note: All participants will receive a sheet with contact information for Dr. Vrana.]

Another thing. Your writing is completely anonymous and confidential. Your writing is coded with an ID number. Please do not include your name in your writing. Some people in the past have felt that they didn't want anyone to read them. That's OK, too. If you don't feel comfortable turning in your writing samples, you may keep/delete them. We would prefer if you turned them in, however, because we are interested in what people write. I promise that none of the experimenters, including me, will link your writing to you. The one exception is that if your writing indicates that you intend to harm yourself or others, we are legally bound to match your ID with your name. Above all, we respect your privacy. Do you have any questions at this point? Do you still wish to participate?

Experimental Condition Instructions

(Do Not state the next sentence to participants in the no training group) I would like you to use the imagination techniques you were just taught in order to more fully involve yourself in recalling and writing about your experiences.

What I would like to have you write about for the next three days is the most traumatic, upsetting experience of your entire life—the same experience that you identified when you filled out a questionnaire earlier about posttraumatic symptoms. In your writing, I want you to really let go and explore your very deepest emotions and thoughts. It is critical that you really delve into your deepest emotions and thoughts. Ideally, we would like you to write about significant experiences or conflicts that you have not discussed in great detail with others. Remember that you have three days to write. 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 and remember to use the techniques you were just taught in order to more fully involve yourself in your writing.

On the Second Day of Writing

How did yesterday's writing go? Today, I want you to continue writing about the most traumatic experience of your life using the techniques you were taught in the first session in order to more fully involve yourself in your writing. While you are recalling your experience, remember to [actually do in your recollection what you were doing in the actual situation] or [involve yourself fully in the sights, sounds, and smells of the actual situation]. I really want you to explore your very deepest emotions and thoughts…and remember to use the techniques you were taught in the first session in order to more fully involve yourself in your writing.

On the Third Day of Writing

Today is the last writing session. In your writing today, I again want you to explore your deepest thoughts and feelings about the most traumatic experience of your life using the techniques you were taught in the first session in order to more fully involve yourself in your writing. While you are recalling your experience, remember to [actually do in your recollection what you were doing in the actual situation] or [involve yourself fully in the sights, sounds, and smells of the actual situation]. Remember that this is the last day and so you might want to wrap everything up. For example, how is this experience related to your current life and your future? But feel free to go in any direction you feel most comfortable with and delve into your deepest emotions and thoughts…and remember to use the techniques you were taught in the first session in order to more fully involve yourself in your writing.

Control Condition Instructions

(Do Not state the next sentence to participants in the no training group) I would like you to use the imagination techniques you were just taught in order to more fully involve yourself in recalling and writing about your experiences.

What I would like you to write about over the next three days is how you use your time. Each day, I will give you different writing assignments on the way you spend 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 and remember to use the techniques you were just taught in order to more fully involve yourself in your writing.

On the Second Day of Writing

How did your writing go yesterday? Today, I would like you to describe what you have done today since you woke up using the techniques you were taught in the first session in order to more fully involve yourself in your writing. While you are recalling your experience, remember to [actually do in your recollection what you were doing in the actual situation] or [involve yourself fully in the sights, sounds, and smells of the actual situation]. Again, I want you to be as objective as possible to describe exactly what you have done up until coming to this experiment… and remember to use the techniques you were taught in the first session in order to more fully involve yourself in your writing.

On the Third Day of Writing

This is the last day of the writing sessions. In your writing today, I would like you to describe what you will be doing over the next week and remember to use the techniques you were taught in the first session in order to more fully involve yourself in your writing. While you are recalling your experience, remember to [actually do in your recollection what you were doing in the actual situation] or [involve yourself fully in the sights, sounds, and smells of the actual situation].

Vita

Andrea Konig was born in New York, and is an American Citizen. She graduated from Saratoga Springs High School in Saratoga Springs, NY in 1993. She received her Bachelor of Arts in Psychology from Skidmore College in Saratoga Springs, NY in 1998. In 2004, she received her Master of Arts in Clinical Psychology/Research from Loyola College in Maryland. She then enrolled in the Clinical Psychology Doctoral Degree program at Virginia Commonwealth University in Richmond, VA. She completed a clinical internship at the Hunter Holmes McGuire VA Medical Center in Richmond, Virginia in August 2011. Andrea will graduate in December 2011 with her doctorate in Clinical Psychology. She will then complete a post-doctoral fellowship at the University of Virginia in the Department of Psychiatry and Neurobehavioral Sciences.