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Using Latent Semantic Analysis to Evaluate the Coherence of Traumatic Event Narratives

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USING LATENT SEMANTIC ANALYSIS TO EVALUATE THE COHERENCE OF TRAUMA NARRATIVES: DO CHANGES IN COHERENCE PREDICT EXPRESSIVE WRITING PARADIGM OUTCOMES?

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University

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Abstract

While a growing evidence base suggests that expressive writing about a traumatic event may be an effective intervention which results in a variety of health benefits, there are still multiple competing theories that seek to explain expressive writing's mechanism(s) of action. Two of the theories with stronger evidence bases are exposure theory and cognitive processing theory. The state of this field is complicated by methodological limitations; operationalizing and measuring the relative constructs of trauma narratives, such as coherence, traditionally requires time- and labor-intensive methods such as using a narrative coding scheme. This study used a computer-based methodology, latent semantic analysis (LSA), to quantify narrative coherence and analyze the relationship between narrative coherence and both short- and long-term outcomes of expressive writing. A subsample of unscreened undergraduates (*N*=113) who had been randomly assigned to the expressive writing group of a larger study wrote about the most traumatic event that had happened to them for three twenty-minute sessions; their narratives were analyzed using LSA. There were three main hypotheses, informed by cognitive processing theory: 1) That higher coherence in a given session would be associated with a more positive reported valence at the conclusion of that session, 2) that increasing narrative coherence across writing sessions would be associated with increasing reported valence at the conclusion of each session, and 3) that increasing narrative coherence over time would be associated with a decrease in post-traumatic stress symptoms. Overall, initial hypotheses were not supported, but higher coherence in the third writing session was associated with more negative valence at the conclusion of the session. Furthermore, relationships between pre- and post-session valence strengthened over time, and coherence, pre-session valence, and post-session valence all trended over time. These results suggest a collection of temporal effects, the implications of which are discussed in terms of future directions.

Introduction

While research suggests that expressive writing about a potentially traumatic event is an effective intervention that can result in a variety of positive health outcomes, including fewer doctor's visits and decreased depressive symptoms (Baikie & Wilhelm, 2005), researchers have not come to a consensus about how expressive writing works. Some researchers theorize that expressive writing is a form of exposure therapy: because participants write about their traumatic experience, they are re-exposed to the trauma in a safe environment and habituate to the distress that was maintaining their symptoms (Jaycox, Foa, & Morral, 1998; Lang, 1979). Other researchers propose the cognitive processing theory, which suggests that because participants write about their trauma, they begin to re-conceptualize what happened to them and think about their experiences in a "healthier" way, which reduces their distress (e.g., Lepore & Greenberg, 2002; Michael & Snyder, 2005; for a general review, see Park, 2010).

One way to conceptualize how participants may engage in novel cognitive processing of an event is to use the construct of narrative coherence (Vrana, Bono, Konig, & Scalzo, 2018). "Coherence" can be defined in several ways; in this setting it is used to describe the extent to which a piece of writing has a consistent meaning, orientation in time and space, and flow (Adler et al., 2018; Foltz, 2007), which is thought to relate to the cognitive representation an individual has for the event they feature in their writing. A narrative that is coherent should be relatively easy to understand and have a consistent theme or purpose. In contrast, a narrative that is not coherent may be difficult to follow because it changes rapidly in content or setting; for example, someone may tell a story in a nonlinear fashion, so that events are not described in the order that they actually happened, which makes establishing a timeline difficult for a reader. Some researchers have also defined coherent narratives as requiring a "beginning," "middle," and “end.” However, not all researchers agree that coherence should be defined by those criteria (Reese et al., 2011).

Disparities in how research groups choose to define coherence make it more difficult to synthesize existing research on coherence (Adler et al., 2018), and thus it is also difficult to study how coherence and cognitive processing theory might apply to expressive writing. Psychologists from a variety of disciplines have created different coding schemes for operationalizing coherence into a construct, and these coding schemes may not necessarily all measure the same underlying factors (Adler et al., 2018). Therefore, it can be difficult to compare the results of different studies that seek to evaluate the coherence of expressive writing narratives, limiting our ability to understand the extent to which cognitive processing gains might predict a participant’s health outcomes. The field may benefit from a more unified operationalization of the coherence construct.

Another barrier to using coherence is that most existing methods of measuring coherence are labor-intensive and subject to human error (Graci, Watts, & Fivush, 2018; Vrana et al., 2018). Coding schemes are implemented by having a small group of people, usually trained research assistants, read a set of narratives and evaluate the writing using pre-defined criteria. For example, one criterion in a scale developed by Lysaker and colleagues (2002) rates the “temporal conceptual connections” of a narrative on a Likert scale from 0 to 3. This process must be repeated for every narrative in a dataset. Coders are typically trained to reliability, meaning that a group meets and discusses the coding scheme ahead of time and makes sure that everyone who will be coding for coherence will give similar ratings under the same circumstances. This helps reduce human error, but the results are still dependent on the judgement of the research group, and it is unclear whether or not two independent research groups would be inter-reliable even if within-group reliability were high, so comparing results between studies is difficult. The other limitation is that even with multiple coders working on a dataset, these methods are significantly time- and labor-intensive because they involve careful reading of many narratives (Graci et al., 2018; Vrana et al., 2018).

Recent advances in computer science may reduce these barriers to researching narrative coherence and could help investigate the cognitive processing theory for expressive writing. Latent semantic analysis (LSA) is a machine-learning tool that began as a theory of how humans learn language (Landauer, Foltz, & Laham, 1998; Landauer, 2007). It uses a large volume of text to create associations between words in order to "learn" what the meaning of each word is in relation to the other words. This is important because it emphasizes that LSA learns in a bottom-up fashion; rather than humans deciding how certain words should be defined or relate to each other, a user simply provides exposure to human language and allows LSA to determine how words are interconnected to form meaning (Landauer, 2007). This is similar to how humans can learn a new language by "immersion;" over time, a person learns which words are used together in which contexts, and therefore figures out the meanings of each word.

Many proponents of using LSA to evaluate language assert that the whole is the sum of its parts (e.g., Landauer, 2007). In other words, the meaning of a sentence is determined by each word in that sentence, and the meaning of a paragraph is determined by all the words in that paragraph. Because LSA is able to evaluate the meaning of a piece of writing (whether it is a single word, one sentence, or an entire essay) in this dynamic way, it can create a measure of coherence (Foltz, 2007). Recall that an important aspect of coherence is that a narrative "makes sense" by having a consistent meaning throughout (Adler et al., 2018). By deconstructing a trauma narrative into its parts (in this study: individual sentences), LSA can evaluate the coherence of the narrative as a whole: how related is each sentence in a narrative to the next sentence? A narrative with contiguous sentences that are more closely related in meaning to each other would be evaluated as more coherent than a narrative with contiguous sentences that have little semantic relation to each other (Foltz, 2007).

Applying LSA to studying the coherence of expressive writing narratives would be beneficial in several ways. Firstly, because LSA is a computer program, it requires significantly less human labor than traditional coding schemes. Once the program is trained, it can evaluate an entire dataset automatically (Vrana et al., 2018). This also reduces the possibility of human error because the process is automated and the way LSA defines coherence will be consistent. Due to the potential benefits of using an LSA program, and in order to test several hypotheses informed by cognitive processing theory, this study will be an initial exploration of the relationship between LSA coherence and select beneficial outcomes of expressive writing.

Literature Review

Expressive Writing

Expressive writing has been shown to have a variety of long-term benefits for participants (Baikie & Wilhelm, 2005; Greenberg, Wortman, & Stone, 1996; Lepore & Greenberg, 2002; Lepore, 1997; Lepore, Greenberg, Bruno, & Smyth, 2002; Pennebaker & Beall, 1986; Pennebaker, Kiecolt-Glaser, & Glaser, 1988). Despite having benefits including improved lung, liver, and immune functioning; reduced psychopathology (e.g., fewer depressive symptoms and intrusive traumatic thoughts); and improved working memory (Baikie & Wilhelm, 2005), the specific mechanisms behind the effects of expressive writing have not been determined. However, several hypotheses regarding these mechanisms have received support in the literature (Sloan & Marx, 2004).

An early hypothesis postulated by Pennebaker and Beall (1986) suggested that the emotional catharsis of being prompted to disclose traumatic events that were being avoided resulted in an alleviation of accumulated stress on both the participant's mind and body, facilitated by a decrease in emotional inhibition (Sloan & Marx, 2004). While catharsis may be a partial explanation, support in the literature has been mixed; for example, research has shown that participants who were asked to write about a fictional trauma they did not actually experience still received the benefits of expressive writing (Greenberg et al., 1996), which would not support the theory that a direct emotional release was needed (Sloan & Marx, 2004). The lack of strong support for a catharsis-like theory has led researchers to explore alternative hypotheses (Sloan & Marx, 2004).

A different hypothesis theorizes that the benefits of expressive writing are imparted by a form of exposure therapy: repeatedly writing about a trauma results in habituation (lessening of fear responses due to repeated encounters) and emotional engagement (active experiencing as opposed to avoidance), and exposure therapy is a well-established treatment for posttraumatic symptoms (Jaycox, Foa, & Morral, 1998; Sloan & Marx, 2004). The support for the emotional exposure theory is incomplete but promising, as outlined in Sloan and Marx's review (2004). Notably, research has shown that an individuals' physiological responses during expressive writing predicts their health outcomes (Konig, Eonta, Dyal, & Vrana, 2014; Sloan & Marx, 2004). Critics of exposure theory have cited research that indicates that individuals do not need to write about the same traumatic event in repeated expressive writing tasks in order to receive the benefits of therapy (Baikie & Wilhelm, 2005; Sloan & Marx, 2004), which suggests that exposure theory cannot fully account for the benefits of expressive writing. However, other groups cite evidence that suggests a general emotional exposure is tied to the experience of writing about traumatic events, rather than being event-specific, which would support exposure theory (Sloan & Marx, 2004).

Yet another hypothesis is that expressive writing provides benefits to participants by facilitating cognitive processing of a traumatic event, which will "promote insight" into cognitive assimilation (Baikie & Wilhelm, 2005; Sloan & Marx, 2004, p. 123). Central to the theory is the idea that an individual's core assumptions are disrupted by the experience of a traumatic event, and therefore these disruptions must be reconciled to reduce symptomology (Horowitz, 1986; Janoff-Bulman, 1992; Sloan & Marx, 2004). The term "meaning making" has also frequently been used by researchers to describe this theorized phenomenon, where individuals process their trauma by reorganizing memories or "reconfiguring" cognitive structures (Park, 2010). Cognitive processing, as it connects to meaning making, is thought to increase the structure, organization, and cohesion of memories associated with the traumatic event, improving the coherence of memory and facilitating more effective coping with posttraumatic stress (Park, 2010).

Writing about an event provides an opportunity for this processing to occur, by prompting the participant to dynamically interact with the overall structure and organization of the traumatic memory in a way they previously had not done (Sloan & Marx, 2004). Central to this is the assertion that an individual's interactions with the traumatic memory are not only emotional but cognitive (Park, 2010). Emotional and cognitive processing are distinguished from each other based on the specific content being reorganized in a traumatic memory: emotional processing focuses on the modification of "maladaptive fear structures" and is equated with the traditional hallmarks of exposure and habituation (Park, 2010, p. 260), while cognitive processing may include acknowledgements of emotion but primarily features the reconceptualization of schemas and other existing beliefs (Park, 2010). As such, cognitive processing theory asserts that expressive writing provides cognitive benefits over and above the emotional restructurings implied by exposure. The support for this is mixed; several studies have suggested that cognitive processing changes do occur over the course of expressive writing, but have not made causal patterns clear (Sloan & Marx, 2004). Additionally, research has suggested that meaning-making attempts are inconsistently successful (i.e., not everyone who attempts to make meaning reports that meaning was successfully made), which complicates the evidence (Park, 2010). In attempts to reconcile the mixed support for these theories, researchers have more recently posited that coherence and emotional intensity (i.e., markers of both cognitive processing theory and exposure theory) may play important, interrelated roles in explaining the benefits of expressive writing (Graci et al., 2018).

One issue with researching the exposure and cognitive processing theories is that quantifying how an event is mentally and emotionally represented has traditionally been difficult, limiting the effective conclusions that can be drawn from past research (Sloan & Marx, 2004; Vrana et al., 2018). A potential way to evaluate the extent to which cognitive processing has occurred is to measure the coherence of the expressive writing narratives. Recall that coherence describes the consistency of meaning, orientation in time and space, and flow of a piece of writing (Adler et al., 2018; Foltz, 2007), which connects to the previously defined process of meaning making (Park, 2010). If meaning making is attempted across expressive writing sessions, then the coherence of the narratives may increase as the individual's perceived meaning, schemas, etc. shift in representation. Initial support for this hypothesis may be found in the recent work of Vrana and colleagues (2018), who analyzed the coherence of expressive writing narratives and found that the coherence of trauma narratives tended to increase over time. Traditionally, evaluating coherence has involved labor-intensive methods that were prone to human error (Graci et al., 2018; Vrana et al., 2018). However, the advent of advanced computer science techniques offers the ability to quantitatively analyze a wide variety of facets of expressive writing with improved efficiency, accuracy, and detail. This study, like the previous work of Vrana et al. (2018), seeks to use one such computer science technique to quantify the change in narrative coherence over time in relation to a particularly short-term outcome of expressive writing, the averseness of emotional experience (valence) felt directly after the expressive writing experience, as well as a longer-term outcome: post-traumatic stress symptoms at a three month follow-up.

Valence has been selected because it may be a useful measure of participants' immediate coping following expressive writing exposure; if higher coherence is associated with more positive emotional valence, then cognitive processing model's theory that increased cognitive processing is associated with improved coping (Baikie &Wilhelm, 2005) will be supported. In addition, valence may successfully capture between-group differences in unselected samples which may have a ceiling effect regarding clinical outcomes, making it an important inclusion. Post-traumatic stress symptoms are a frequently reported outcome for evaluating expressive writing interventions (e.g., Konig et al., 2014; Koopman et al., 2005; Smyth, Hockemeyer, & Tulloch, 2010).

Coherence

Existing methods for quantifying narrative coherence primarily rely on coding schemes developed by various research groups. In a recent study, Adler and colleagues (2018) compared three commonly used coding schemes from several areas of psychological research in order to determine onto which underlying factors each coding scheme may load. The three coding schemes studied by Adler and colleagues (2018) hailed from developmental psychology (Reese et al., 2011), personality research (Baerger & McAdams, 1999), and clinical psychology (Lysaker et al., 2002). Baerger and McAdams' (1999) coding scheme, with ties to both personality and developmental literatures, sought to represent "the sense of unity" (Adler et al., p. 31) that is considered central to life stories' narrative identity, featuring four dimensions: orientation, structure, affect, and integration. Reese and colleagues (2011) similarly focused on a developmental framework but had a greater emphasis for use in childhood. This coding scheme features three dimensions of context, chronology, and theme (Reese et al., 2011). Finally, the coding system developed by Lysaker and colleagues (2002) was specifically developed to assess deficits in narratives written by individuals with schizophrenia; therefore the scale was intended to include a broader range of potential incoherence. The three dimensions are logical connections, richness of detail, and plausibility (Lysaker et al., 2002).

Adler and colleagues (2018) conducted a Principal Components Analysis (PCA) on all dimensions of the three aforementioned coding schemes by applying the systems to a single dataset of life story narratives. The PCA produced a solution of three components, with dimensions from different coding systems loaded onto single components (Adler et al., 2018). While commonly used, the three coding schemes studied by Adler are not an exhaustive list. In fact, a long-standing coding scheme for coherence that was specifically designed for use in coding trauma narratives, developed by Foa and colleagues (1995), was not included. Another coding scheme for evaluating narratives of trauma was recently developed (Fernandez-Lansac & Crespo, 2017) but has not been as widely studied. These coding schemes are similar to those studied by Adler and colleagues (2018) in that they contain dimensions that evaluate specific facets of coherence, though they include significantly more dimensions than the aforementioned three scales: twelve in Fernandez-Lansac and Crespo's (2017) scale, and thirteen in Foa and colleagues' (1995) scale. These scales further exemplify some of the current difficulties with measuring narrative coherence, particularly the labor-intensive nature and how diverse the scales are from each other.

As previously touched on, one difficulty with researching coherence has been the disparity in how various research groups operationalize the construct (Adler et al., 2018), which can be seen in the distinctions between the dimensions defined by the five coding schemes featured in this review. Several research groups have advocated for the unification of coherence as a construct (Adler et al., 2018; O'Kearney & Perrott, 2006; Vrana et al., 2018). Additionally, these human-coded scales are time- and resource-intensive (Vrana et al., 2018), which creates another barrier to effective research. In contrast to these approaches, a computer-programmed latent semantic analysis (LSA) of coherence is more standardized and less labor-intensive (Vrana et al., 2018), which could improve the reliability, ease, and effectiveness of coherence measurement. As such, LSA has been selected as the approach for measuring coherence in this study, and will be described in more detail below.

Latent Semantic Analysis as a Measure of Coherence

Latent semantic analysis (LSA) is a flexible approach to text analysis that uses bottom-up methodology by evaluating the meaning of a word *in context* with its relationship to other words (Vrana et al., 2018). LSA is a mathematical technique, which can be programmed as computer software that is trained in inductive reasoning; programmers "teach" LSA how to interpret language by allowing it to observe the interrelations between words in a training corpus of language (Landauer, Foltz, & Laham, 1998; Landauer, 2007). Theorized to be similar to how humans learn language, LSA establishes a network of word meanings to understand which words express similar concepts, meanings, and other aspects of cognition (Landauer et al., 1998; Landauer, 2007; Landauer & Dumais, 1997). LSA ultimately assumes that the meaning of a passage must be a function of the meanings of the individual words in the passage (Landauer, 2007). To put it simply, this method asserts that the whole is the sum of its parts.

LSA is trained by being exposed to vast amounts of natural language; the type of language LSA is exposed to will vary based on the user's purpose (e.g., an individual interested in analyzing students' responses to a psychology essay question may want to train their LSA program using psychology textbooks) and must be carefully selected (Landauer, 2007). Once given a corpus, LSA will create a matrix that represents how often words occur in relation to each other and from where they occurred (Landauer et al, 1998; Landauer, 2007; Landauer & Dumais, 1997). For example, the word *bacteria* may frequently appear in a biology textbook, but significantly less frequently appear in a physics textbook, and LSA will account for these disparities in its matrix. *Bacteria* would also be likely to co-occur in a passage that uses the term *organism;* in contrast, *organism* will be unlikely to appear in the physics textbook, and these patterns of occurrence also contribute to how LSA learns about contextual meaning.

The analysis does not stop with a direct measure of co-occurrence. This is because words that are highly synonymous may have high levels of semantic similarity but not occur together in a single text (Landauer, 2007). For example, *doctor* and *physician* are highly related words that would likely not occur in close proximity, because they serve nearly identical functions in a passage. Therefore, LSA creates a weighted system that will compare each word both to the specific text it came from *and* to the rest of the documents in a given corpus (Landauer et al., 1998). To expand on the previous example, LSA would consider that *doctor* and *physician* themselves may not frequently co-occur, but would both co-occur with words such as *stethoscope* and *examination,* and therefore learn that *doctor* and *physician* are semantically similar. It is within this web of contextual relationships that LSA evaluates the meaning of a passage based on the meaning of the individual words (Landauer, 2007).

In contrast to the coding schemes described in the previous section, which delineate aspects of coherence using specific dimensions, LSA's method of evaluating coherence uses a related but distinct definition: coherence is the quality and extent of conceptual linkage within a passage, and is calculated mathematically rather than rated by Likert scale (Foltz, 2007). A passage with a large quantitative coherence would have semantically-related content throughout the text; a passage low in coherence would contain disparate semantic meanings in different parts of the text (Foltz, 2007). For example, a passage that described both bacteria and higher-level plant life would likely be evaluated as more coherent than a passage that described both bacteria and quantum physics. While each passage may potentially have appropriate transition words and related structural features, the general, thematic meaning of the first passage (based on the semantic interconnectedness of the words within) would likely be more coherent.

In this way, LSA's evaluation of meaning (both with respect to coherence and other applications) may function similarly to the way humans process language by relying on the concept of *gist* (Foltz, 2007). That is: both LSA and human language users focus on the overall conceptualized meaning of a passage by analyzing what, in general, a passage communicated, and how well the parts of a passage shared meaning to communicate a single idea, thought, or feeling (Foltz, 2007). LSA does not focus on the cohesion of a passage, which is a related term that focuses on connections between nearby sentences and the "flow" of a passage (Foltz, 2007) and one semi-frequently looped into traditional coding schemes (e.g., Baerger & McAdams, 1999; Lysaker et al, 2002; Reese et al, 2011). It is important to remember this limitation when conceptualizing what an LSA measure of coherence can tell us about a passage (Vrana et al., 2018).

Coherence will be evaluated in this study by using the LSA website's Sentence Comparison method (Dennis, 2007). This is an iterative method that correlates the first sentence in a passage to the second sentence, the second sentence to the third sentence, et cetera, and the correlations between each pair of sentences are averaged to create the mean correlation of the text: the overall coherence score (Dennis, 2007; Foltz, 2007; Vrana et al., 2018). As with a typical correlation, scores range from 0 to 1, where values closer to 1 indicate higher coherence and values closer to 0 indicate poorer coherence (Foltz, 2007). It should not be assumed that higher coherence is necessarily ideal; in fact, a moderate coherence score may be an indication of optimum cognitive processing (Foltz, 2007; Vrana et al., 2018). A document too low in coherence will likely be disorganized in a way that indicates poor cognitive processing, whereas a document high in coherence may indicate that no new information is being presented or discussed, suggesting that novel processing has not occurred (Foltz, 2007; Vrana et al., 2018).

Statement of the Problem

Expressive writing is an established intervention that may provide a variety of health benefits to participants processing traumatic events (Baikie & Wilhelm, 2005). Despite research supporting the health benefits of expressive writing, the mechanisms by which writing leads to positive outcomes are still unclear (Sloan & Marx, 2004). One proposal follows the cognitive processing theory, which suggests that expressive writing results in improved health outcomes because the process of repeatedly writing about a traumatic event allows the individual to form a more coherent conceptualization of the event, which decreases the distress caused by the memories of said event (Sloan & Marx, 2004; Baike & Wilhelm, 2005; Park, 2010).

The present study seeks to synthesize and extend previous analyses conducted on an expressive writing data set collected from unscreened undergraduate students (Konig et al., 2014; Vrana et al., 2018). Vrana and colleagues (2018) analyzed the coherence of the narratives and found that coherence was higher for neutral-topic narratives, but trauma narratives showed a significant increase in coherence over time. The finding that trauma narratives showed increased coherence over time has interesting implications for the theorized mechanisms of change in expressive writing therapy, particularly relating to cognitive processing theory. Cognitive processing theory suggests that the increases in narrative coherence that Vrana and colleagues (2018) identified will be associated with improved health. Therefore, the objectives of the present study are to investigate: 1) the single time-point relationship between narrative coherence and short-term outcomes, 2) the relationship between changes in coherence over time and short-term outcomes, and 3) the relationship between changes in coherence over time and longer-term health outcomes. As a secondary goal, this study seeks to provide preliminary support for the use of LSA as a broader methodology in the field of clinical psychology.

Statement of Hypotheses

The following hypotheses are proposed:

1. If a narrative's coherence is an important mechanism of action for expressive writing therapy, then higher coherence in a given session should be associated with a more positive reported valence at the conclusion of that session. This should be true for all three writing sessions.

2. If increasing narrative coherence is an important mechanism of action, then increases in narrative coherence across the three writing sessions should be associated with an increase in positive post-session valence in the third session, compared to the valence reported after the first session. This would indicate that as a narrative became more coherent, the emotional experience associated with that narrative became more positive.
3. Increasing narrative coherence may also be associated with a longer-term health outcome. Increased coherence across the three writing sessions should predict a decrease in total posttraumatic stress symptomology after a one-month follow-up.

Method

The narratives analyzed in this study were collected by Konig and colleagues (2014) at a large, public mid-Atlantic university in the United States, and were subsequently analyzed with LSA coherence by Vrana and colleagues (Konig et al., 2014; Vrana et al., 2018).

Participants

Participants in this study were undergraduate students (N=246), who were unscreened for either traumatic experiences or posttraumatic symptoms, and received course credit for participation. The majority of the sample identified as female (72%) with an average age of 21 years old. The sample was 48% Caucasian, 28% African American, 27% Asian, 2% Hispanic, 1% Native Hawaiian or other Pacific Islander, and 10% endorsed the 'other' category.

Writing Conditions

Following the typical protocol for expressive writing, participants wrote on three days within a two-week period for twenty minutes each day. Participants in the expressive trauma writing condition were told to write a narrative about the most traumatic event they had personally experienced, adding as much emotional expression as they could (Konig et al., 2014). The instructions were to write about the same event during each session; on the first day, they were told to freely explore the topic, on the second day, they were told to focus on expressing their most sincere thoughts and feelings, and on the third day they were told to conclude the narrative (Konig et al., 2014). Full writing instructions for the expressive writing group are presented in Appendix B. Participants in the neutral topic condition were asked to avoid using emotional language (Konig et al., 2014). Because this study seeks to investigate the relationship between expressive writing therapy and narrative coherence specifically, narratives from the neutral condition were not included in the present analysis (final N = 113).

Procedure

Participants completed the study individually in the lab across three separate sessions over a two-week period, producing one writing sample during each session. At the beginning of the first session they signed informed consent documents and were assured of confidentiality. At baseline before session one, demographic information and psychological assessments were filled out, including a measure of post-traumatic stress symptoms (Konig et al., 2014). Imagery training[1] and a brief deep breathing exercise were administered, then a 10-minute baseline period was established, and finally participants wrote for a 20 minute session (Konig et al., 2014). The second and third sessions only involved the expressive writing task, with no imagery or breathing exercises. Participants were asked to self-report their emotional valence both before and after each writing session on a 9-point Likert scale, where 1 indicated “unhappy, displeased”

[1] This imagery training was included to test hypotheses related to how response training may affect physiological responses during expressive writing (for results, see Konig et al., 2014), and is not relevant to the current study. As such, it will not be discussed further in the main body of this text. For a description of this training procedure, see Appendix A.

and 9 indicated "happy, content, pleased." Finally, follow-up questionnaires were mailed one month after the third session. Physiological measures beyond the scope of this study were also collected during the first and third writing sessions (Konig et al., 2014).

Changes in posttraumatic symptomology were measured using the Davidson Trauma Scale (DTS; Davidson et al., 1997), a measure that assesses the severity and frequency of PTSD symptoms experienced in the last week, where 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 (McClernon, Beckham, Mozley, Feldman, Vrana, & Rose, 2005). The DTS was administered at baseline before session one and again as part of the follow-up battery one month after the third session.

Measures

Coherence: Vrana and colleagues (2018) performed standard textual data cleaning in order to process the writing samples through LSA. These procedures included the replacement of numerals with words and the removal of certain punctuation (e.g. parentheses) that are not processed by the LSA website, as well as the correction of spelling errors (Vrana et al., 2018). Vrana and colleagues (2018) extracted coherence scores with the Sentence Comparison tool on the LSA website (http://lsa.colorado.edu) using empirically supported parameters (Landauer et al, 1998; Landauer, 2007; Landauer & Dumais, 1997; Vrana et al., 2018). Specifically, the semantic space was built on a corpus of varied readings, up to the first-year college level, and with the maximum (300) number of factors available to represent the data. The Sentence Comparison tool evaluates coherence using an iterative sentence-to-sentence comparison, where the first sentence is correlated with the second sentence, the second sentence is correlated with the third sentence, etc. until the entire narrative is evaluated. The mean correlation between the sentences is then calculated to calculate an overall coherence score for each narrative ranging from 0 to 1, where higher scores indicate more coherent narratives.

Change in coherence: The change in coherence was calculated by subtracting the coherence of the first session's writing sample from the coherence of the third session's writing sample. A positive score indicated that a narrative became more coherent over time while a negative score indicated that a narrative became less coherent over time.

Valence: As previously stated, participants were asked to self-report their emotional valence both before and after each writing session on a 9-point Likert scale, where 1 indicated "unhappy, displeased" and 9 indicated "happy, content, pleased."

Davidson Trauma Scale: The DTS (Davidson et al., 1997) provides severity and frequency subscales as well as a total score. For the present study, the severity score was used.

Data Analysis

Prior to analysis, the data were assessed for the assumptions of normality, multicollinearity, and residuals' normality. Due to violations of the normality assumption (i.e., pre-session valence data were skewed > -1.0), the data were first reflected and then a square root transform was performed on the valence data; this transform successfully resolved violations of the normality assumption. Because the valence data were reflected in order to properly address the negative skew, *higher* valence scores now indicate more *negative* mood and the results will be interpreted as such. Twenty-one cases were removed due to significant missing data (i.e., coherence data was unavailable; final $N = 92$).

Hypothesis One

To test the first hypothesis, three separate hierarchical multiple regressions, one for each writing session, were performed in order to predict participants' self-reported valence after each session. In the first step, pre-session valence was entered into the model in order to control for the baseline valence before writing. In the second step, narrative coherence for the session was entered into the model in order to evaluate whether or not narrative coherence significantly predicted valence over and above the model created using pre-session valence for that session.

Hypothesis Two

To test the second hypothesis, a hierarchical regression analysis was used to model the extent to which the change in narrative coherence across sessions predicted the post-session valence after the third writing session. In the first step, post-session valence after session one was entered into the model in order to control for baseline valence after expressive writing. In the second step, the coherence change score was entered into the model in order to evaluate whether or not change in narrative coherence over time significantly predicted post-session valence at the conclusion of the expressive writing protocol, over and above the post-session valence for the first session.

Hypothesis Three

To test the third hypothesis, a hierarchical regression analysis was used to model the extent to which the change in narrative coherence across sessions predicted post-traumatic stress symptoms after a one-month follow-up period. In the first step, post-traumatic stress symptoms measured before the expressive writing intervention was entered into the model to control for baseline. In the second step, the coherence change score was entered into the model in order to evaluate whether or not change in narrative coherence over time significantly predicted posttraumatic stress symptoms after a follow-up period, over and above the baseline symptomology.

Results

Table 1 displays untransformed means and standard deviations for the pre- and post-session valence for each session, coherence at each session, change in coherence, and PTSD symptoms severity and baseline and follow-up. Notably, previous analyses conducted on this data found a significant *increasing* trend for coherence (Vrana et al., 2018) and an increase in positive valence (Konig et al., 2014) across the three sessions

Table 1: Descriptive statistics of main variables of interest.

	N	Minimum	Maximum	Mean	Std. Deviation
Valence Pre Session 1	113	3.00	9.00	7.2566	1.32812
Valence Post Session 1	113	1.00	9.00	5.3717	2.08393
Valence Pre Session 2	110	2.00	9.00	6.9182	1.66525
Valence Post Session 2	110	1.00	9.00	5.5364	1.81066
Valence Pre Session 3	107	1.00	9.00	6.8411	1.84876
Valence Post Session 3	107	2.00	9.00	6.0935	1.87603
Coherence Session 1	94	.13	.52	.3082	.06870
Coherence Session 2	93	.11	.56	.3254	.08518
Coherence Session 3	90	.18	.49	.3364	.06974
Coherence Change	90	-.21	.18	.0273	.07610
DTS severity - Baseline	110	.00	63.00	18.9545	14.70404
DTS severity – Follow-up	89	.00	59.00	11.2360	13.19437
Valid N (listwise)	73				

Table 2 displays a correlation matrix of all the aforementioned variables. As can be seen in the table, the participants' valence reports were significantly inter-correlated. PTSD symptom severity at baseline and follow-up, as measured by the DTS, was also correlated with valence at multiple time points. Additionally, change in coherence was significantly positively correlated with the pre-session valence at session 3 (r^2=.297, $p < .01$). Pre- and post-session 3 valence were *negatively* correlated with the coherence of the *first* session's narrative (r^2=.251, $p < .05$ and r^2=.234, $p < .05$, respectively).

Table 2: Correlation matrix of main variables of interest.

	Valence Pre Session 1	Valence Post Session 1	Valence Pre Session 2	Valence Post Session 2	Valence Pre Session 3	Valence Post Session 3	Coherence Session 1	Coherence Session 2	Coherence Session 3	Coherence Change	DTS Severity Baseline	DTS Severity Follow-up
Valence Pre Session 1	1	.375**	.307**	.316**	.194*	.248*	-.109	-.093	-.116	-.017	-.208*	-.283**
Valence Post Session 1	.375**	1	.234*	.566**	.146	.508**	-.048	.007	-.097	-.043	-.298**	-.331**
Valence Pre Session 2	.307**	.234*	1	.508**	.414**	.313**	-.178	-.133	.034	.190	-.158	-.153
Valence Post Session 2	.316**	.566**	.508**	1	.340**	.564**	-.094	-.030	-.148	-.043	-.233*	-.196
Valence Pre Session 3	.194*	.146	.414**	.340**	1	.663**	-.251*	-.033	.079	.297**	-.284**	-.190
Valence Post Session 3	.248*	.508**	.313**	.564**	.663**	1	-.234*	-.033	-.107	.113	-.361**	-.351**
Coherence Session 1	-.109	-.048	-.178	-.094	-.251*	-.234*	1	.524**	.400**	-.543**	.235*	.158
Coherence Session 2	-.093	.007	-.133	-.030	-.033	-.033	.524**	1	.456**	-.050	.104	-.065
Coherence Session 3	-.116	-.097	.034	-.148	.079	-.107	.400**	.456**	1	.553**	.189	.042
Coherence Change	-.017	-.043	.190	-.043	.297**	.113	-.543**	-.050	.553**	1	-.043	-.102
DTS Severity - Baseline	-.208*	-.298**	-.158	-.233*	-.284**	-.361**	.235*	.104	.189	-.043	1	.621**
DTS Severity – Follow-up	-.283**	-.331**	-.153	-.196	-.190	-.351**	.158	-.065	.042	-.102	.621**	1

*** Correlation is significant at the .01 level* **Correlation is significant at the .05 level*

Hypothesis One

Session 1

When the pre-session valence for this session was entered into the model, it significantly predicted post-session valence, $F(1, 92) = 9.379$, $p = .003$, $R^2 = .093$. This initial model shows that 9.4% of the variance in post-session valence could be predicted by knowing the participant's pre-session valence. When the coherence score for session one's narrative was added to the model, it did not significantly improve the prediction, $\Delta R^2 = .000$, $\Delta F(1, 91) = .001$, $p = .970$. The final regression model for each hypothesis is presented in Appendix C.

Session 2

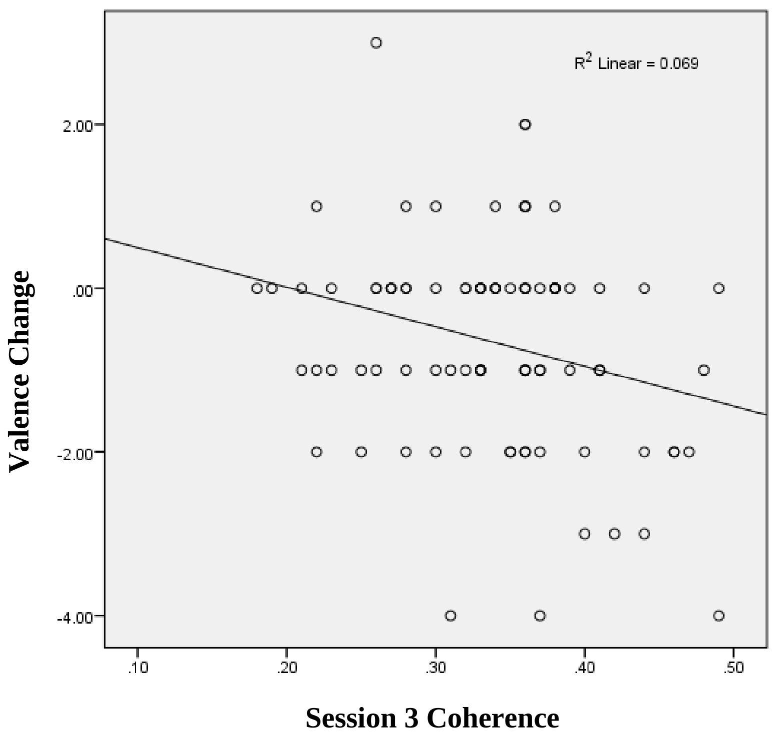
When the pre-session valence for this session was entered into the model, it significantly predicted post-session valence, $F(1, 90) = 40.773$, $p < .001$, $R^2 = .312$. This initial model shows that 31.2% of the variance in post-session valence could be predicted by knowing the participant's pre-session valence. When the coherence score for session two's narrative was added to the model, it did not significantly improve the prediction, $\Delta R^2 = .001$, $\Delta F(1, 89) = .175$, $p = .676$.

Session 3

When the pre-session valence for this session was entered into the model, it significantly predicted post-session valence, $F(1, 87) = 122.746$, $p < .001$, $R^2 = .585$. This initial model shows that 58.5% of the variance in post-session valence could be predicted by knowing the participant's pre-session valence. When the coherence score for session three's narrative was added to the model, it significantly improved the prediction, $\Delta R^2 = .029$, $\Delta F(1, 86) = 6.491$, $p = .013$. The coherence score ($\beta = .165$) predicted an additional 2.9% of unique variance in post-session 3 valence. Higher coherence scores were associated with higher valence scores in the *model;* recalling that valence scores were reflected during the data cleaning phase, this means that higher coherence was associated with more *negative* emotional valence.

In order to help interpret the relationship between the narrative coherence in the third session and the post-session 3 valence, a scatterplot of session 3 coherence and change in valence from pre- to post-session 3 is presented in Figure 1 for illustrative purposes. This graph plots the coherence score against an *untransformed* valence change score, which is the valence before writing during session 3 subtracted from the valence after writing during session 3. Valence change scores are plotted to illustrate the effect of covarying out pre-session valence; in this transformation lower scores mean more negative valence after expressive writing compared to before. A regression line was added to show the best linear fit of the data, in which coherence accounted for 6.9% of the variance in valence change scores. As can be seen in the Figure, higher coherence is associated with a more negative valence after writing.

Figure 1: The relationship between session 3 coherence and the change in valence from pre- to post-session 3.



Hypothesis Two

The second hypothesis is that a positive change in narrative coherence over time would be associated with a positive change in post-session valence over time. When the post-session valence for session 1 was entered into the model, it significantly predicted post-session valence for session 3, $F(1, 87) = 25.123$, $p < .001$, $R^2 = .224$. This initial model shows that 22.4% of the variance in post-session 3 valence could be predicted by knowing the participant's post-session 1 valence. When the change in coherence of a participant's narratives over time was added to the model, it did not significantly improve the prediction, $\Delta R^2 = .018$, $\Delta F(1, 86) = 1.993$, $p = .162$. The linear coefficient for change in coherence ($\beta = -0.133$; $p = .162$) was in the predicted direction, where increased coherence was associated with increasingly positive valence over time.

Hypothesis 3

The third hypothesis was that a positive change in coherence over time would be associated with a lower severity of PTSD symptomology at follow-up compared to baseline. When the baseline measure of PTSD symptom severity was entered into the model, it significantly predicted PTSD symptoms at follow-up, $F(1, 71) = 48.870$, $p < .001$, $R^2 = .639$. This initial model shows that 63.9% of the variance in PTSD symptom severity at follow-up could be predicted by knowing the baseline PTSD symptom severity. When the change in coherence over time was added to the model, it did not significantly improve the prediction, $\Delta R^2 = .000$, $\Delta F(1, 70) = .011$, $p = .917$.

Discussion

Overall, the hypotheses of this study were not supported. While the majority of the findings were null results, the first hypothesis, that greater coherence of a written narrative would significantly predict more positive post-session valence, was unsupported for the third session because a significant relationship between the variables of interest was found in the opposite direction of the hypothesis: a more coherent narrative was associated with more *negative* valence at the completion of the writing session. There are several possible interpretations of this result. Firstly, because the valence score was reported immediately after the completion of the writing session, the result that higher coherence predicts negative valence may be reflecting that individuals who engage in the experience of writing more fully by focusing on a more coherent account of their traumatic memory are more intensely exposed to negative emotions associated with the memory. This would indicate that writing a less coherent narrative may be connected to avoidance. Alternatively, the result may be a product of individual differences in emotional memories: a more traumatic experience may result in a more tightly-interconnected memory, making for a more coherent narrative when that memory is accessed (Lang, 1979). Cognitive processing associated with developing a coherent narrative may also require a higher cognitive load, and the toll of this load could contribute to a more negatively-valenced experience. A more coherent narrative might also be the result of deeper emotional processing of the memory, which would also lead to a more negatively-valenced experience (Lang, 1979).

Several interesting temporal effects found in this data are consistent with theories positing that expressive writing affects changes in narrative coherence and emotional valence over time: Correlations (see Table 2) showed that the relationship between pre- and post-session valence tended to strengthen across sessions, suggesting that participants came more prepared to process their trauma narrative with each successive writing session. Similarly, pre-session valence become more negative across sessions, suggesting that participants arrived to their second and third writing sessions anticipating that they were going to process their trauma memories. In contrast, post-session valence became more positive across sessions, suggesting habituation of the negative memories. Finally, coherence and post-session valence were significantly related only in the third session. Previous analyses conducted on this dataset found that the coherence of trauma narratives significantly increased across sessions (Vrana et al., 2018). One hypothesis that synthesizes these findings, and is consistent with both CPT and exposure theories, is that the effects of expressive writing are partially time-dependent, in that cognitive processing changes that result in a more coherent narrative require several writing sessions to take place. Thus, the coherence of a given narrative may only be relevant during later sessions, after other mechanisms of action have had an effect (i.e., one hypothesis is that an exposure mechanism, which habituates writers to the negative emotional experiences associated with their memories, is prerequisite for cognitive processing to occur). This hypothesis would require significant replication to be supported, and potentially a more sophisticated analysis than simple hierarchical regression (discussed further below). However, if supported, this hypothesis would align well with theories that have suggested that expressive writing offers benefits over and above traditional exposures (Sloan & Marx, 2004) and would also support Graci and colleagues' (2018) proposal that factors such as coherence and emotional intensity should be analyzed in tandem.

Because a relationship between narrative coherence and post-session valence emerged in the final session, it is unclear whether the association is related to the number of sessions or the fact that the third session was the final session; notably, participants knew that the third session would be their last opportunity to write a narrative in this context (and were in fact encourage to "wrap up" their narratives; the full writing instructions given to participants can be found in Appendix B), which may have influenced their writing. By adding more sessions in future studies, it would be possible to more thoroughly assess the effect of time and assess if cognitive processing continues to occur past a third session. Alternatively to these hypotheses, the significant result of the session 3 hierarchical regression may be an artifact of repeated analyses, and simply reflect type 1 error. This possibility further emphasizes the need for replication/extension of this study.

Hypotheses two and three, that the change in coherence over time would predict post-session 3 valence and PTSD symptom severity at follow-up, respectively, were not supported. In both cases, there was not a significant relationship between the change in coherence over time and either post-session 3 valence or PTSD symptom severity. While null results should not be interpreted in and of themselves, there are several possible ways that future work could be informed by the results of this study. If the study were replicated and null results were found again, this would indicate that the current theoretical framework that informs the hypotheses may not be the best model for continued work.

Limitations

An additional consideration is the limits of external validity in the current study. The participants in this sample were unscreened undergraduate students who were eligible for participation regardless of their trauma histories and level of depressive and PTSD symptoms. While there was only weak support for a relationship between coherence/change in coherence over time and participants' outcomes in this study, these results may not generalize to a clinical population; the relevance of and capacity for novel cognitive processing may be greater for participants in more clinical distress who potentially have more disorganized cognitions involving their traumatic experiences. Future studies would greatly benefit from recruiting a sample of treatment-seeking and/or clinically distressed participants with a history of at least one traumatic event.

Finally, this type of longitudinal data may be more appropriately modeled by a more comprehensive analysis, such as time series analysis, that can account for autocorrelation and more complex relational patterns. For example, previous research has found that coherence increases over time (Vrana et al., 2018) and that valence tends to become more positive across sessions (Konig et al., 2014). Findings such as these suggest that autocorrelations, where coherence and valence change over time and are partially predicted by their previous values, may interfere with the current model and be better addressed explicitly (rather than indirectly with a method such as hierarchical regression). A time series analysis or similar technique may also be better suited for addressing Graci and colleagues' (2018) proposal that emotional exposure and cognitive processing constructs should be analyzed in tandem because it can account for the temporal effects previously discussed, including the hypothesis that emotional exposure may be prerequisite for cognitive processing. However, there is some debate regarding whether or not time series analysis can be applied to data that consist of relatively few (i.e., 3 sessions) time points (Jebb, Tay, Wang, & Huang, 2015); further, adequate power for a time series analysis would require more participants than are in the current study. Advisable next steps would be to further investigate the most appropriate uses of time series analysis and/or consider similar alternatives in a larger study. Additionally, follow-up studies could be designed with more points of data collection (e.g., by increasing number of sessions) in order to address the concerns about data volume.

Summary

Overall, the results of this study have offered only weak support for a hypothesized relationship between narrative coherence/change in coherence over time and the outcomes of an expressive writing intervention, but these results have informed further hypotheses and potential avenues for future work. Due to the null results, no strong conclusions can be made about the applicability of cognitive processing theory to expressive writing's mechanism(s) of action at this time. Similarly, the utility of LSA as a method for evaluating coherence should be continued to be explored.

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Appendix A: Training Conditions

Following an established procedure (Miller et al., 1987; Peasley-Miklus & Vrana, 2004), subjects participated in one of two imagery training conditions before engaging in the first writing session. Both training conditions were 45 minutes long and featured four action-oriented scripts which lacked references to emotion. The response training scripts referred to behavioral and physiological responses, while the stimulus training scripts focused on descriptive details. After each script, participants were encouraged to imagine the script and describe their imagery out loud.

In the response training condition, the training was designed to encourage participants to use more response-oriented descriptions, such as verbal responses, overt motor actions, and physiological responses such as “my hands were sweating” (Lang, 1977). Participants who included response-oriented descriptions were provided positive feedback; participants who did not include such content were encouraged to do so in the remaining trials. In contrast, the stimulus training condition was designed to increase the participant’s use of sensory details, such as descriptions of the scenery. The stimulus training condition was intended as an active comparison control to response training, as supported by prior research (Lang et al., 1980). A third group of participants served as an additional control by receiving no training at all.

Appendix B: Writing Conditions

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.

Appendix C: Regression Models

Table 3: Regression Models for Hypothesis 1

DV	IV	Unstandardized Beta	t-value	Standardized Beta	*p*-value
Post-session 1 Valence					
	(Constant)	2.105	1.841		.069
	Pre-session 1 Valence	1.484	3.041	.305	.003**
	Session 1 Coherence	.408	.141	.014	.888
Post-session 2 Valence					
	(Constant)	1.050	1.271		.207
	Pre-session 2 Valence	2.305	6.189	.555	<.001**
	Session 2 Coherence	-1.227	-.635	-.057	.527
Post-session 3 Valence					
	(Constant)	-2.299	-3.106		.003*
	Pre-session 3 Valence	2.757	11.576	.778	<.001**
	Session 3 Coherence	4.187	2.451	.165	.016*

** indicates p < .05   ** indicates p < .01*

Table 4: Regression Model for Hypothesis 2

DV	IV	Unstandardized Beta	t-value	Standardized Beta	*p*-value
Post-session 3 Valence					
	(Constant)	6.213	12.830		<.001**
	Pre-session 1 Valence	-.426	-5.096	-.479	<.001**
	Change in Coherence	-3.071	-1.412	-.133	.162

** indicates p < .05   ** indicates p < .01*

Table 5: Regression Model for Hypothesis 3

DV	IV	Unstandardized Beta	t-value	Standardized Beta	*p*-value
DTS Severity – Follow-up					
	(Constant)	.040	.021		.983
	DTS Severity - Baseline	.548	6.865	.640	<.001**
	Change in Coherence	1.613	.105	.010	.917

** indicates p < .05* *** indicates p < .01*

Vita

Gabby Scalzo was born in Virginia Beach, Virginia, and is an American citizen. They graduated from Ocean Lakes High School in Virginia Beach, VA in 2009, then received their Bachelor of Science in Psychology and Neuroscience from Virginia Polytechnic Institute and State University with Highest Honors, in Blacksburg, VA in 2013. At Virginia Tech, Gabby worked as a research assistant for Dr. Lee Cooper and Dr. Andrea Scarpa. In the fall of 2013, she enrolled in the Clinical Psychology Doctoral Degree program at Virginia Commonwealth University in Richmond, VA under the mentorship of Dr. Scott Vrana. Gabby intends to continue their excellent training as a scientist-practitioner of clinical psychology at VCU.